

Religion and Science at the Turn of the Century

North Americans live in a place and at a time when the practice of religion seems to be making a comeback. Even though Western Civilization has long embraced a secular approach to daily life, banishing religion to the private realms of personal morality, spiritual devotion, and ecclesiastical ritual, many orthodox Christians, Jews, and Muslims continue to assert the public relevance of their faith. This is obviously true in politics, where a number of moral agendas are being pursued, but religious concerns have also been broached in other areas, such as biotechnology research, energy use, and environmental care.

The case of science is an interesting one, as this provided the core inspiration and wellspring of revelation for Enlightenment humanism. The grand success of natural science during the 17th and 18th centuries in unlocking the secrets of the physical universe prompted secular thinkers to extrapolate and advocate a rational approach to all of life. Individual subjectivity due to religion, ethnicity, class, or personal bias was to be suppressed in order to attain universally true objective knowledge that all people could acknowledge as a common basis for organizing the world and living together. Religious and metaphysical notions were deemed vestiges of an earlier time in human history, when nothing better was available. But once the era of science had arrived, these childish ideas and concerns were to be cast aside or, at the very least, circumspectly kept in their place. When religious interests refused to be so closeted, secular thinkers fought back. Notably, this occurred in connection with late 19th and early 20th century debates over Darwinian evolution. That was also the time when historians of science began more vigorously promoting the thesis that there is an essential tension between religion and science.

In our day this mythic tale of conflict is well known: Galileo and Darwin are the innocent martyrs of science; the Roman Catholic Church and the conservative religious leaders of the 19th and 20th centuries are the bigoted persecutors whose censorship sought to muzzle the free development of unbiased physical and biological science. This story originates with the work of John William Draper in 1874 (*History of the Conflict between Religion and Science*) and Andrew Dickson White in 1876 and 1896 (*The Warfare of Science* and *A History of the Warfare of Science with Theology in Christendom*). Of course, their assessment of the relation didn't go unchallenged. A number of authors even went on the offensive, claiming not only that there was no genuine conflict, but that some strands of Christian belief were responsible for the rise of modern science. Reijer Hooykaas's 1972 *Religion and the Rise of Modern Science* makes the case for Protestant Christianity (in a Calvinist form), while Fr. Stanley Jaki's 1974 *Science and Creation* makes a similar argument for Catholicism.

By the 1980s, historians were beginning to take a more nuanced look at the relations between religious beliefs and scientific developments, and they tried to move the discussion beyond the apologetic projects of their predecessors. An important book in this regard was the 1986 collection of specialized essays *God and Nature: Historical Essays on the Encounter between Christianity and Science*, edited by contributors David Lindberg and Ronald Numbers. Five years later John Hedley Brooke published his influential book *Science and Religion: Some Historical Perspectives*, which also argued for the complexity of the connections. Since that time, the new orthodoxy in history of science has been to acknowledge (and demonstrate) that the relationships between science and religion in Western Culture have been quite complex throughout their long history, involving salutary influences and sharp antagonisms and benign neglect, with complicating factors going in all directions. A neat and simple answer to how science and religion are related, therefore, is no longer forthcoming, even if we could all agree on what counts as science and religion in each time and place.

Three books recently published by The Johns Hopkins University Press comprise a short but comprehensive series on science and religion in Western Culture – *Science and Religion: A Historical Introduction* (2000; 2002 paperback), a collection of essays edited by Gary Ferngren; *Science and Religion, 400 B.C. to A.D. 1550: from Aristotle to Copernicus* (2004; 2006) by Edward Grant; and *Science and Religion, 1450 – 1900: from Copernicus to Darwin* (2004; 2006) by Richard Olson, the editor of the series. These books carry the program of complexification further, exhibiting a wide range of relationships between science and religion. Besides tracing the history of the relation, volumes 2 and 3 include some excerpted primary source materials (about 30 pages each, in English) to make them more readily accessible to readers. I will review each of these books in turn, noting as we proceed what might be of particular interest in them for a mathematician or mathematics educator.

The first book is primarily a republication of encyclopedia entries, 30 in all, written by a group of distinguished experts in the fields covered. The articles treat a variety of times and topics pertinent to the issue, grouped together under seven main headings. In addition to a few general and historiographic articles, the authors take up several different eras (pre-modern, early modern, nineteenth century, twentieth century), some key scientists (Galileo, Newton, Darwin), different stripes of theologians (early Protestants, Roman Catholics, fundamentalist evangelicals), and a number of natural sciences (astronomy, physics, geology, biology).

The rich variety present in *Science and Religion: A Historical Introduction* can't be summarized briefly, but I will single out a few articles that I found especially interesting. The second entry, by David Wilson, on *The Historiography of Science and Religion* gives a short but scholarly overview of approaches to the book's topic. This article provides a good entrance into the field for anyone wanting a roadmap of how the relationship has evolved over the last century or so. Owen Gingerich's article on *The Copernican Revolution*, like other entries, is fairly brief (ten pages), but it is interesting and informative. It shows how various Christians reacted to Copernicanism in the centuries following the publication of the 1543 masterpiece *On the Revolutions of the Heavenly Bodies*. The article on *Early Modern Protestantism* by Edward Davis and Michael Winship discusses various theology-science connections in a way that demonstrates an intimate familiarity with the theological doctrines being treated, something that isn't always the case when contemporary historians discuss religious beliefs. Richard Westfall, whose book *Never at Rest* is considered the definitive scientific biography of Isaac Newton, here contributes a fascinating article on the character and scope of Newton's theology and its place in his overall thought and scientific work. The entry by James Moore on *Charles Darwin* is one of the most engagingly written pieces in the entire collection, demonstrating a broad knowledge of the time period as well as of Darwin's thought. This is followed by Peter Bowler's article on *Evolution*, which is a good companion piece on the reception of Darwin's ideas in various quarters. Readers interested in the development of Creation Science or Intelligent Design can turn to several articles toward the end of the book, including ones by Ronald Numbers and William Dembski. This topic is also touched upon in an earlier article by John Hedley Brooke on *Natural Theology*, a theme that reverberates throughout the book. Christians have seemingly always debated to what extent and in what ways one could argue for a knowledge of God the Creator from evidences all around us in what he has made.

Science and Religion, 400 B.C. to A.D. 1550: from Aristotle to Copernicus was written by the prominent medievalist Edward Grant. Grant's entire long career has been devoted to researching, writing on, and teaching about medieval science and its connections to medieval philosophy and theology. It soon becomes apparent to the reader that Grant's knowledge of medieval history and philosophy of science is nearly as vast as his topic.

The book begins by describing the ancient intellectual soil from which medieval thought grew (chapters 1-3). Besides outlining the main features of Aristotle's comprehensive natural philosophy, Grant discusses the role of science and natural philosophy in Greek and Roman cultures more generally.

He then proceeds chronologically through the Middle Ages, looking first at early Christian thinkers' ideas on natural philosophy (4), then at the recovery of ancient Greek thought and the attendant growth of universities and Western scholarship in the twelfth and later centuries (5-6), and finally at the interactions between natural philosophy and theology in the 14th and 15th centuries (7). His concluding chapter (8) summarizes some key differences in the relations between science and religion in the Byzantine Empire, the world of Islam, and the Latin West, explaining why modern science arose in Western Europe.

One of Grant's main aims, here as in his career generally, is to establish that medieval thought was not the scientific backwater many have claimed it to be. That bigoted caricature was begun by 17th and 18th century thinkers who considered themselves more enlightened than their philosophical and religious forebears living in the so-called Dark Ages. Grant demonstrates that such a view fails to square with the facts. While medieval academics are not modern thinkers, they exhibited intellectual curiosity about a wide range of scientific topics and proposed innovative ideas that bore fruit both at the time and later on. It is quite interesting to read the many specifics that undergird this thesis, but at times this rehabilitation goal seems to steer the book away from the topic of its title, making it more diffuse. In fact, there are a number of places where Grant pays little or no attention to the relation between religion and science, but simply details the development of natural philosophy. The connection of religion and science is a main focus in chapter 1, but chapters 2 and 3 have almost nothing directly on the topic – in part because (as I argue below) Grant has a rather narrow notion of what religious beliefs are all about.

The introductory chapters, then, contain very little commentary on the interaction between scientific thought and religious belief; they are seemingly included to round out a history of science narrative and set the stage for examining medieval thought. Only in chapter 4 does the topic get seriously under way, a third of the way through the book. Here the early church fathers' views of pagan philosophy and its proper relation to and use in Christian thinking is surveyed. The usual cast of characters makes its appearance here: Tertullian, Philo, Justin Martyr, and others, including Augustine, of course, whose ideas exerted a strong influence on later medieval Christian thought. Christian thinkers accepted what they knew of pagan natural philosophy insofar as it was a proper handmaiden to theology, to help do things such as explicate the creation story or calculate the precise date of Easter for each year. Of course, not all philosophical systems or doctrines were religiously benign, for Greek philosophers often said things about creation or the gods that were diametrically opposed to the Scriptural account. Such ideas needed either to be defused and harmonized or else opposed; both tacks were taken in a variety of ways by early medieval Christian thinkers, setting the tone for later interactions.

By the late-12th century to the mid-13th century, medieval Europe was beginning to experience more rapid cultural growth. New towns and cities grew up, more widespread trade and commerce developed, and university education commenced in a number of places. Theological reflection had already begun to display an increasingly rationalistic character in some thinkers, with logical ideas and practices often dominating their approach to resolving ecclesiastical debates and organizing theological doctrines. With the recovery of Aristotle's philosophical corpus via translation from Arabic and Greek sources, this tendency became even more pronounced, and the need to come to grips with sophisticated pagan Greek thought about the world became more urgent. Christian scholars now had a far more extensive and mature natural philosophy available to them than what they had encountered earlier in the portions Boethius and others had bequeathed to them in their summaries and commentaries. Religious conflicts occasioned by Aristotle's philosophical doctrines arose at Paris and elsewhere in the 1200s; these are documented by Grant in some detail. The synthesis achieved by Thomas Aquinas in the mid-13th century formed the main basis for later discussions relating faith/theology and reason/natural philosophy. Theology was the queen of the sciences, treating matters known through divine revelation; secular knowledge such as that of natural philosophy was of a lower order, being generated by the light of human reason. Where these areas of thought touched upon a common matter, divine revelation and theology were to be given priority. That was the theory, anyway. In practice, natural philosophy was increasingly

given free reign in its domain, needing no input from theology, so long as it didn't challenge or contradict religious dogma. Theology, on the other hand, at times required natural knowledge and rational argumentation to assist it in developing a deeper understanding of Scripture and doctrine.

In the 14th and 15th centuries, it became increasingly difficult to keep the two realms confined to their assigned domains. Topics like the nature and possibility of a vacuum, the impenetrability of matter, the nature of infinity, the locomotion of bodies, continuity, time, and others had to be discussed with some theological sensitivity and trepidation, always allowing God to do whatever He willed in accord with being omnipresent and omnipotent, including create counterfactual situations or connections that might contravene Aristotelian common sense. But the strongest links between religion and natural philosophy were forged in the theological treatises of the time. Many of these works were creative rational discourses on a wide variety of philosophical topics, such as those just mentioned, though often veiled as discussions about creation or God or angels.

Toward the end of the Middle Ages mathematics, logic, and physical science had made a rather substantial impact on theology, turning it into something more akin to natural philosophy than a systematic science of supernatural religious doctrines. At the same time, theologians were the recognized experts in revealed knowledge; they were the ones who interpreted Scripture and decided what view to take when the biblical account seemed to be in conflict with natural philosophy. They usually did this, however, without taking the Bible's statements about natural phenomena too literally. Following in the footsteps of Augustine and Thomas, they noted that Scripture sometimes uses popular language that is only superficially at odds with more precise natural knowledge.

In the book's final chapter, Grant notes that the separation of church and state as well as of faith and reason that largely characterized Western thought had no parallel in the Byzantine Empire or the Islamic Empire. Consequently, those cultures were less willing to accept Aristotelian philosophy or develop natural philosophy further, independent of religion. Natural science, therefore, only found the fertile soil it needed to grow in Western Europe, where it was mostly free from religious intrusion. Conflicts could still arise, but in principle each realm was free to pursue its goals independently of the other.

There is much in this book to help us understand how various medieval thinkers approached the topic of religion and science. Grant gives his reader a good sense of the main trends and the rich tapestry of medieval thought. Nevertheless, I found certain aspects of the work less than satisfying. My main criticism of the book is its overall framework for dealing with the topic. I kept wanting to reinterpret what Grant was telling me because I found his approach to and understanding of the issue to be too "medieval." Religion, as he understands it, has to do with believing the dogmas of divine revelation, science with drawing rational conclusions about the world, and these are very different things having little relevance to one another (cf. pp. 13-14, 23, 101-3, 203-206, 224, 247-8). Such a dualistic formulation of the issue is not the only one available; nor, it seems to me, is it very defensible in a post-positivist era when we know more about personal subjectivity in knowledge and scientific work. Having set religion and science up as two separate epistemic realms at the outset, Grant is unable to penetrate behind them to examine what worldview or philosophical paradigm might be at work in both, what basic religious orientation might underlie both the natural philosophy and the theological reflection of a time period. I wanted a deeper analysis of how a basic religious belief in what is divine might impact the rest of a person's thought, whether or not a specialized theological doctrine was involved. Given his narrow locus for religion (theological doctrines, such as the incarnation or transubstantiation), however, Grant fails to see how medieval natural philosophy might be permeated by religious concerns and sensibilities; in fact, he takes pains to argue against this very viewpoint, explicitly advanced by others (pp. 203-6).

Grant's two-realm conceptualization of the problem doesn't permit very many fruitful possibilities for interconnecting science and religion. Consequently, his conclusions are sometimes at odds with the very

material he is presenting. Grant notes near the beginning of the book that the relationship between faith and mathematics “is decidedly one way: it was the exact sciences that could exert influence on theology and religion, but there was virtually no feasible way that religion could influence the content of the mathematical sciences.” (p.24) And yet, in talking about significant trends in the 14th century, he asserts that it was the theologians who brought up various topics that were later developed into new mathematical ideas – the ideas of infinity, of quantitative variation, of continuity. Grant sometimes treats the motivation of these topics as wholly irrelevant, but other times he notes that these topics were discussed more creatively by the theologians, out of their concerns, than by the natural philosophers (pp.218-220). The medieval analysis of infinity, among other things, provides a striking counterexample to Grant’s claim of the non-influence of theology on the content of mathematics. Cantor, for example, found stimulation and solace in his reading of medieval thinkers as he was developing his theory of transfinite numbers in the late-19th century. It seems to me, therefore, that Grant has too readily adopted a medieval separation of faith and reason, and that he too quickly applauds, in editorial fashion, the latter’s independent scientific development during early modern and Enlightenment times (pp. 247-8). This skews his erudition and makes his work less valuable than it could have been if he had rethought the conventional way in which the issue was set up.

This reservation, notwithstanding, I found several topics related to mathematics of interest in the book. Grant’s discussion of the 14th century in particular touched upon a number of mathematical developments, as noted above. In addition, Grant shows how ideas and trends in mathematics and medieval logic impacted the structure, organization, and subject matter of theology for some thinkers. Certain theological treatises of the time were more discourses on mathematics and natural philosophy than on revealed truths from Scripture. This somewhat curious development tied mathematics and theology more closely together, and it exhibits the esteem in which mathematics and logic were held in medieval times, regardless of how poverty-stricken mathematics was then from a technical standpoint.

The third book in the series, *Science and Religion, 1450 – 1900: from Copernicus to Darwin* by Richard Olson, proved a marked contrast for me to the one just discussed. Whereas I expected to learn a number of new things from Grant’s discussion of medieval philosophy and theology, areas I’ve not researched in any depth, I thought I had a decent understanding of the subject covered by Olson from my earlier reading in philosophy of science and my familiarity with the history of the exact sciences. I therefore anticipated something of a rehash of material I already knew. But having studied and thoroughly enjoyed Olson’s earlier work *Science Deified and Science Defied: The Historical Significance of Science in Western Culture* (Volume 2, 1990; 1995 paperback), which covers some of the same ground, I thought I would at least find his treatment well organized and interestingly presented. I was in for a very pleasant surprise. Not only did the third volume of this series read well, but it contained much that was new to me. Olson’s meticulous treatment of the rich variety of interconnections between science and religion was a refreshing revelation. The book does an excellent job of documenting the complex tangle of interconnections between religious thought and scientific work during this time period. Drawing upon numerous primary and secondary sources, Olson develops his case without becoming pedantic or swamping the book with scholarly minutiae.

The bookend chapters for this work are explorations of the Galileo affair and the religious responses to Darwinian evolution. These are the obvious case studies to bracket a historical examination of modern interactions between science and religion. Between Chapters 1 and 8 Olson considers what different religious views contributed to science and how various scientific developments and outlooks affected theology and religious beliefs. He begins in Chapter 2 by looking at Renaissance Christian and Greek philosophical inputs into the rise of modern science. Various Catholic contributions and responses to scientific developments are discussed in Chapter 3, while Anglican and Puritan involvement in and attitudes toward theology, natural knowledge, and mechanical philosophy are treated in Chapter 4. Chapter 5 is devoted to Newton’s religious thinking and its connection to his natural philosophy as well

as to later deistic Enlightenment thought, and Chapter 6 examines various ways in which modern science was used to develop positions on religion and theology. Chapter 7 considers earth science and pre-Darwinian views on origins in order to set the stage for discussing Darwinian evolution in the final chapter.

The first chapter of Olson's book sets out the problem in a more sophisticated way than Grant had. Olson analyzes and rejects the positivist claims that religion and science provide competing visions of the world and that in the modern age the latter has properly superseded the former. On the other hand, he says, even while the general aims of science and religion are different, this does not mean that they cannot and do not come into contact with one another. Modern developments demonstrate many influences, going in both directions. For one thing, unexamined cultural assumptions and the conceptual apparatus of ordinary language often underlie the practice of both religion and science, bringing them into close proximity. Further, personal and institutional links tie the two fields together. Many important scientists are also involved in religious thought, and they inevitably carry over ideas, emphases, dispositions, and methodological criteria from one area into the other. At times, religious and scientific institutions are in competition for scarce resources, but each frequently embodies practices and ideas that are imported from the other realm or from some other area of culture. All this makes the actual relationships very complex. Thus, when controversy arises (as it is thought) between science and religion, the conflict usually has other sources and factors working below the surface – personal, political, ideological, etc. – that make it into something quite different than it seems on the surface. Olson illustrates this approach by highlighting a number of important considerations involved in the Galileo affair, factors that argue against it being a simple case of biased religious censorship of objective scientific thought. He continues to argue for and exhibit the same rich variety of connections between religion and science as he moves on into the other topics of the book.

Olson's treatment of the early modern era (chapters 3 – 5) shows how various religious strains of thought and ecclesiastical affiliations tended to influence and respond to the development of science. The picture the reader gets from this is very different from what was put forward by the more one-sided treatments several decades ago. Calvinist, Anglican, and Catholic thinkers displayed typical attitudes toward natural science that encouraged it in certain ways and not others, and Olson shows how these different responses were often intertwined with political and ecclesiastical developments of the time. Jesuit thinkers, for example, emphasized the importance of all learning as a divine calling. They tended to promote mathematical thinking in the exact sciences as well as scientific experimentation. There one could reason both hypothetically (as was done earlier in astronomy) and contingently (trying to uncover how the world actually works), without dogmatically asserting something as either necessarily true or as the true underlying cause of some phenomenon – views that might later run afoul of the religious authorities. As a result, Jesuits comprised a disproportionate number of mathematicians, scientists, and educators in the early modern era, authoring a number of important scientific works and textbooks. To take another example, a number of Catholic thinkers and many Protestants were attracted to a mechanistic approach to natural philosophy because of their religious convictions. Knowing, as we do, that such an approach led many in the 18th century to adopt a deistic outlook, we may find this appeal incongruous and puzzling, but in the early- to mid-17th century Christian thinkers were looking for a way to reject animistic and magical viewpoints of nature. Accepting a mechanical universe seemed to many to be the best way to affirm the need for a transcendent Creator who nevertheless remained active in keeping the world running well. As a final example, we learn from Olson's treatment that British thinkers, both Puritans and various kinds of Anglicans, tended to support some forms of and approaches to science more on account of their eschatology and their political leanings than for any rational scientific reasons. Olson also notes how natural theology entered into attempts to establish and maintain a strong national (Anglican) church, and what various Christians thought of this approach, which eventually evolved into a form of natural religion for some. The tradition of presenting scientific design arguments to prove the

existence of a Creator was popular in England for centuries and was destined to play a role in mid-19th century discussions of origins.

As a historian of mathematics, I was particularly intrigued by Olson's informative and fascinating analysis of the Renaissance transition from medieval thought patterns to modern science (chapter 2). This was the time period in which natural philosophy was transformed from being rather bookish and focused on why things happen (teleology) to being more descriptive, experimental, and utilitarian. Olson explains how certain religious trends of late medieval and Renaissance times (millenarian concerns, voluntaristic theology, and nominalism) fed these changes in scientific focus and method. This was also the time when a mathematical approach to understanding the world made a strong resurgence. Mathematics was thought to provide tools for describing the behavior of nature and plumbing its deepest secrets. This belief seems commonplace and rather obvious to us today, for we are the heirs of the scientific revolution advanced by Kepler, Galileo, Descartes, Newton, Leibniz, and others. Their work in the physical sciences confirmed the fruitfulness of such a viewpoint. The surprising thing documented here, though, is how much this outlook owes to magic and mystical speculations, even heresy, for getting off the ground. The ideal of mathematizing our knowledge of nature has deep and ancient roots in Pythagorean and Platonic philosophies, but in Renaissance times this gets strongly conjoined with emerging hermetic notions about the influences exercised by heavenly bodies and geometric shapes and numbers on cultural and natural events. Neo-Platonic ideas are mixed with unorthodox views of Creation and human nature to produce the belief that Man is destined to predict and control Nature through various occult arts such as alchemy and astrology and numerology. Naturally, mathematics' association with such seamy trends doesn't negate the genuine connections that mathematical investigations were to reveal, but people tend to think of mathematics and natural science as sober rational enterprises that have nothing in common with such non-scientific religious tendencies. It pulls one up short, therefore, to see how the new scientific outlooks actually developed historically and in what quarters they found encouragement and sustenance from the late-15th through the mid- to late-17th century.

I've only begun to mine Olson's book with my summary. Many readers will want to learn about the interaction between Newton's scientific and religious thought. Interestingly, his rules for philosophizing about nature had strong parallels (and sometimes precedents) in his approach to interpreting biblical prophecy, an undertaking that generated far more written Newtonian material (unpublished) than did his work on science and mathematics. Some readers may be interested to discover what the new trends in 18th and 19th century theology (deism, anthropology of religion, Comte's religion of humanity, the historicity of Jesus, inductive Bible study, etc.) drew from contemporaneous developments in scientific circles. And those who want to get a good sense of the scientific and religious context in which Darwin developed his theory of origins as well as see how various religious traditions responded to his evolutionary ideas will want to study the final two chapters. There is much more that I could say, but space dictates that I leave further exploration for those who take the book up for themselves.

So, who should read these books? Certainly anyone interested in investigating the relations between Christianity and science in a scholarly way will benefit from the series. Given the nature of such seminal episodes as Galileo's defense of Copernicanism and Darwin's promotion of evolutionary origins, this will include people interested in astronomy, biology, geology, and related areas. But beyond this group, and considering the usual readership of the ACMS online journal, I think a number of mathematicians and mathematics educators will find the books of some interest, partly for treating cognate areas of thought and partly for taking up various topics and time periods directly relevant to mathematics' development, as mentioned above. Since the series is available in a relatively affordable paperback format (each book retails for around \$20), I believe these books may find the broad audience they deserve.