

PERSPECTIVES on Science and Christian Faith

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*"The fear of the Lord
is the beginning of Wisdom."*

Psalm 111:10

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2. Authors must submit an electronic copy of the manuscript formatted in **Word** as an email attachment. Typically 2–3 anonymous reviewers critique each manuscript submitted for publication.
3. Use endnotes for all references. Each note must have a unique number. Follow *The Chicago Manual of Style* (16th ed., sections 14.1 to 14.317).
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James C. Peterson

Fitting

How fitting that the lead article in this December issue uses the science of astronomy and other sources to date the birth of Jesus. *Perspectives on Science and Christian Faith* exists to contribute to the scholarly discussion of how the world's largest, and still growing, global movement (the Christian faith) interacts with the sciences. Science and Christianity have centuries of dialog behind them, and there is always more to consider. For most readers of this journal, both are among the best sources of insight that we have. Studying where they challenge or instruct each other is fruitful and important. Articles and reviews are selected for this journal that contribute to that task. Specifically as a peer-reviewed journal, we are looking for contributions that offer insights that are new, arguably true, well communicated, and of interest to our audience. I will devote future editorials to each of these essential characteristics. Here I will address the focus of *PSCF*.

In a search-engine world, we do not lack input. The problem is not volume; it is having time to sort through the information to find what is potentially worthy of attention, and to verify its accuracy. *PSCF* editors, coordinators, board members, peer reviewers, and authors invest countless hours in evaluating what is offered to the journal and scanning further for what else should also be considered. The result is that if one keeps up with *PSCF*, one should hear about the new ideas, developments, and resources at this intersection. The journal format is not published as instantly as a blog, but it is verified to be more considered and trustworthy. It cannot be as extended in argument as a book, but it is much more timely, each article is more focused, and more authors and approaches are presented.

Essays are chosen that establish something helpful for the journal's readers. That can be a grand synthesis, but more often it is something modest.

An article that thoroughly works through a small but important point can make a real contribution. In this issue, James Nollet takes pages to establish when Jesus was born, since dates have been proposed from 4 BC to AD 6. Nollet is pursuing a turning point of history, not just for our calendar, and offering another affirmation of the historical concern and accuracy of Matthew and Luke. It is instructive that their accounts and those of the early church writers that followed, fit quite well with the referenced astronomical events of their day.

We also see the Christian faith and science connected in Thomas Davis's article. His expert excavation in Crete gives clues to the cultural orientation of various cities that are prominent in the book of Acts. The archaeological findings provide evidence of perceptive accuracy in Luke's description, and offer an enriched context for understanding the theological development of the Apostle Paul. Davis sees Paul deeply affected by living out his life in the particular places of a particular time.

Offering a personal communication on serving as a scientist in a particular time and place, James Nichols reflects on his sense of calling as a Christian and as a scientist. He teaches biology and chairs that department at a Christian university. We will hear in future issues from Christians who are scientists working in places such as international development, government standards, administration, corporate research, and research-intensive universities.

The contributors and readers of this journal are not only serving in different contexts, but also in a striking breadth of disciplines. This is a resource that offers unusual opportunity for cross-disciplinary insight and correction. As a professor of chemical physics at Carnegie Mellon University, Gary Patterson describes some missteps from theologians building on a mistaken notion of entropy. In contrast,

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he thinks that properly understood thermodynamics can offer substantial theological insight. Few journals are able to draw this way from so many of the impinging disciplines for the most complex problems such as origins or the nature of humanity. While this diversity is a distinctive strength, it does mean that forty pages on a detail of an eighteenth-century scientist are not likely to carry interest beyond the five other historians thinking about that particular scholar's life. Yet even a study that is minutely focused can become a fruitful contribution to the journal's audience if it illustrates or implements an insight or approach of broader import.

In all these explorations, *PSCF* does not promise infallibility. What the peer-review process does warrant is trust that proffered views have been tested and found compelling by experts in the involved fields. That is light years ahead of the blogosphere. If it appears in *PSCF*, there are scholars who take it seriously. However, that does not mean that *PSCF* claims to state official positions of the American Scientific Affiliation or the Canadian Scientific and Christian Affiliation. Those who write for the journal and those who read it, do not have to sign a statement of faith or even be members of the founding association. The journal is read far beyond the association membership. For example, in the last months, permission has been granted to reprint articles in Chinese, German, Japanese, and Spanish. Further, back issues of the journal are readily available and widely read over the worldwide web.

The reach is global, but no one journal can address everyone about everything. Our pages are dedicated to serving people interested in how the life-giving Christian tradition interacts with the best of science. For example, Keith Miller's piece in this issue articulates how scientific consensus works, for those who as fellow Christians and citizens need to interpret findings concerning climate change.

Each article is blind peer reviewed for accuracy and plausibility. By plausibility, I mean that the perspective is a genuine possibility, not necessarily the only possibility. The word "Perspectives" is intentionally plural in the journal title. At the leading edge of inquiry, multiple perspectives are almost always in play. An essay that divides peer-review evaluation because of a controversial but thoughtful,

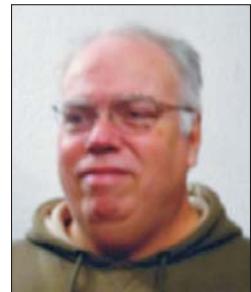
well-presented argument, might well appear in the journal. Publication here means that the approach is worthy of attention, not that it is settled. There is always room to learn more. The articles and book reviews published in *PSCF* are to spur and enable that pursuit. Enjoy. ★

A Psychology Challenge

Science is constantly moving. **Heather Looy**, professor of psychology at The King's University College, has written an intriguing description of the latest developments in psychology with insights and challenges that they may raise for Christian faith. The essay can be read at www.asa3.org or www.CSCA.ca.

This article is intended as an invitation. Readers are encouraged to take up one of the insights or challenges, or maybe a related one that was not mentioned, and draft an article that contributes to the conversation. These can be sent to Looy at Heather.Looy@KingsU.ca. She will send the best essays on to peer review, and then from those we will select some for publication in a psychology theme issue of *Perspectives on Science and Christian Faith*. For full consideration for inclusion in the theme issue, manuscripts should be received electronically before February 28, 2013.

For those readers who prefer to take a literary approach in sharing their ideas, please submit essays (up to 3,000 words), poetry, fiction, or humor inspired by Looy's invitational essay to emily@asa3.org for possible publication in *God and Nature* magazine.



James A. Nollet

Astronomical and Historical Evidence for Dating the Nativity in 2 BC

James A. Nollet

It is commonly accepted that Jesus Christ was born either before 4 BC (working from references in Matthew, Flavius Josephus) or after AD 6 (working from information in Luke). However, Flavius Josephus's dates are unreliable and sometimes argue against themselves. Astronomically, the eclipse of March 13, 4 BC, is highly unlikely to have been the eclipse which Josephus states heralded the death of King Herod, who, therefore, did not die in 4 BC; neither did Herod die in 3 BC or 2 BC, since there were no lunar eclipses visible in Judea in those years. However, 1 BC had two eclipses; either of these, more likely the latter, was the eclipse which just preceded Herod's death. Herod, therefore, died either in 1 BC or AD 1, and Jesus, therefore, was born either from 3 BC to 1 BC, or from 2 BC to AD 1. The Quirinius census of Luke's gospel was not the Quirinius census of AD 6, but rather the Pater Patriae census in 2 BC. Jesus was probably born then in 2 BC. This date is consistent with the records of Matthew, Luke, Irenaeus, Clement of Alexandria, and Eusebius.

When I attended Catholic parochial schools, the nuns taught us that Jesus was born "in the Year 0."¹ Today, it is generally taught that Jesus was born during or before 4 BC. But there is no actual record of this date. This supposition rests solely on Flavius Josephus's passing remark that a lunar eclipse occurred shortly before King Herod died, and we know there was an eclipse visible in Jerusalem on March 13, 4 BC. Since we know from the Gospel of Matthew that Jesus was up to two years old or younger when Herod died, this means Jesus could have been born as early as 6 BC. This date, however, seems to clash with the Nativity account in Luke, which says that the Nativity occurred during a census conducted by the Roman Governor of Syria Quirinius, who we know conducted a census of Judea in AD 6. This article proposes that the likeliest date of the Nativity was not 4 BC, but instead about 1 BC. This is also the year when

Herod actually died, and it reconciles the apparent discrepancy of dates in the Nativity accounts of Matthew and Luke.

There are actually many estimates for the year of the birth of Jesus. Some of the earliest include the placement of the birth of Jesus in the 44th year of the reign of Emperor Augustus, about 3–2 BC by Irenaeus in AD 180.² In AD 194, Clement of Alexandria estimated that Jesus was born 194 years before the death of the emperor Commodus who died on the last day of AD 192; therefore Jesus was born around 2 BC.³ Early in the fourth century, Eusebius wrote that Jesus was born in the 42nd year of the reign of Augustus, and in the 28th year after the death of Cleopatra.⁴ Leaving aside the issue of inclusive or exclusive counting, that places the birth of Jesus at around 2 BC. The Gospel of Luke states that

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there was a “universal census” of the entire Roman world shortly before Jesus was born, when P. Sulpicius Quirinius was governor of Syria. Quirinius was governor twice, in 3 BC and in AD 6.⁵ However, we generally and popularly suppose that Luke was referring to the latter term, because that was the year in which a local census for taxation purposes occurred; this would mean that Luke exaggerated when he spoke about a census of the whole (Roman) world.

According to Josephus, Augustus sent Quirinius to be governor of Syria at the same time that he sent Coponius to be the first procurator of Judea,⁶ stating also that this census occurred in the 37th year “after Caesar’s victory over Antony at Actium” (31 BC)⁷ which, counting inclusively, brings us to AD 6. However, we will see that Josephus was wrong on many of his dates. Therefore, as a working hypothesis, I regard it as possible that Josephus got his fact wrong about Coponius, confusing Quirinius’s first term as governor with his second term. If so, most of the discrepancy between the dates of the Nativity which exists between Luke and Matthew vanishes, thereby placing Luke’s census and subsequent Nativity, not in AD 6, but in 2 BC, and as we will see, the other apparent discrepancies between Luke and Matthew vanish as well.

John P. Pratt summarizes the dominant argument very well and succinctly for Jesus’s birth from 6 BC to 4 BC, and I will begin by simply quoting from him.

Josephus says that Varus was Governor of Syria at Herod’s death and Varus is indeed indicated as such in 4 BC by coins.⁸ The problem, pointed out by Martin,⁹ is that the coins also show Varus was Governor in 6 and 5 BC, whereas Josephus indicates that Saturninus was Governor for the two years preceding Herod’s death.¹⁰ Martin’s solution is that an inscription found near Varus’ villa, which describes a man who was twice Governor of Syria, probably refers to Varus. If so, his second term could well have been about 1 BC, when there is no record of anyone else as Governor.

...

The principal source for the life of Herod is the works of (Flavius) Josephus, a Jewish historian who wrote near the end of the first century. *His methods are not always clear and he is sometimes inconsistent so care must be exercised to cross-check*

his chronology with other sources. Events that are also dated in Roman history are usually the strongest evidence to correlate his history with our calendar. Josephus states that Herod captured Jerusalem and began to reign in what we would call 37 BC, and lived for 34 years thereafter, implying his death was in 4–3 BC. Other evidence both from Josephus and coins indicates that his successors began to reign in 4–3 BC. Moreover, Josephus also mentions a lunar eclipse shortly before Herod’s death.¹¹ For centuries the evidence from astronomy has appeared decisive; a lunar eclipse occurred on March 13, 4 BC, whereas there was no such eclipse visible in Palestine in 3 BC. Thus, the eclipse has played a crucial role in the traditional conclusion that Herod died in the spring of 4 BC.¹² (Emphasis added)

In short, the primary, and perhaps sole basis for the belief that Jesus was born from 6 BC to 4 BC depends on Josephus’s account of the death of Herod and the eclipse he reported.

Some scholars have noted that the 4 BC eclipse is unsuitable, because it happened only one month before that year’s Passover. Therefore, during that month, the following had to occur: (a) Herod became sick and died of a horrible wasting disease, but not before (b) being taken to warm baths and treated; (c) executing his son Herod Antipater after also having made him co-regent (causing a bemused Caesar Augustus to observe that it was better to be Herod’s pig than his son, since Jews do not kill or eat pigs); (d) dying and being buried after a magnificent funeral which needed days to prepare; (e) this was followed by a seven-day mourning period and (f) followed by yet another mourning period for those whom Herod had executed before the eclipse. These scholars believe that one month is not nearly enough time to account for all these events, so they have browsed around for other eclipses which give a more generous and realistic span of time for these events to unfold.

For this reason, Timothy D. Barnes preferred the eclipse of September 15, 5 BC;¹³ six months is enough time for all the above events to occur. However, Ernest L. Martin disagreed, arguing that this would mean that Herod Archelaus would have waited six months, until after the following Passover, before going to Rome and asking Caesar Augustus to confirm him as the next king.¹⁴ And furthermore, if

Herod died some time in 5 BC, then that could mean that Jesus conceivably was born in 7 BC, which is simply too early; Quirinius was not yet governor of Syria.

Josephus dated the length of Herod's kingship in two different ways. (1) Josephus says Herod received his kingship from two of the three triumvirs, Marcus Antonius (Antony) and Gaius Octavius (the future Caesar Augustus) in the year Gnaeus Domitius Calvinus (for the second time) and Gaius Asinius Pollio were consuls, which was 40 BC;¹⁵ from this date he counts 37 years to Herod's death. (2) Josephus says Herod captured Jerusalem and killed his chief rival in the year when Marcus Agrippa and Caninius Gallus were consuls (37 BC), and thereafter ruled for 34 years. However, in this case, and since Jewish regnal years commenced on 1 Nisan,¹⁶ that would mean that Herod's first year began around the time of the vernal equinox in the spring of 36 BC, and if Herod died in the 34th year of his reign thereafter, he would have died in 3 BC or even 2 BC. And in fact, if Herod died shortly before Passover, then according to Josephus's 34-year countdown from the time of the taking of Jerusalem, Herod *had* to have died early in 2 BC. Even if we count from 1 Nisan in the year 37 BC as the first year of Herod's rule, then Herod *had* to have died early in the year 3 BC. So already, we have good reason to discount using the eclipse of 4 BC as the herald of Herod's death.

Furthermore, Josephus says that Herod captured Jerusalem on *Yom Kippur*, the Day of Atonement, also the anniversary of the Roman Proconsul Gnaeus Pompeius Magnus's (Pompey) capture of Jerusalem 27 years earlier.¹⁷ Since Pompey did that in 63 BC, it would mean that Herod actually captured Jerusalem, not in October 37 BC, but in October 36 BC. And if this is the case, we can move the *earliest* possible date for the death of Herod to 1 BC, or maybe 2 BC. There was no eclipse of the moon visible in Judea either in 3 BC or in 2 BC, so it therefore seems that Herod could *not* have died in these years either.

With regard to the coins issued by Herod's sons indicating that they began their reigns in 4 BC, Pratt argues thusly. Before Herod executed his son Herod Antipater, he allowed Antipater to become co-regent with him. This happened around 4 BC. After Herod

himself died, his surviving three sons, who became tetrarchs, all antedated their own reigns back to the time when Antipater was co-regent, in order to keep an unbroken chain between themselves and the deceased Antipater, thereby giving their own reigns more legitimacy.¹⁸

Since we are already highly skeptical as to whether Herod really died in 4 BC, let us look more closely at that eclipse of 4 BC, which for centuries has been regarded as the herald of Herod's death. Can we find evidence which will further strengthen or weaken the supposition that Herod died in 4 BC? The eclipse commenced at 12:07 a.m. Jerusalem Local Time in Jerusalem on the night of March 12–13, 4 BC.¹⁹ In any lunar eclipse, a "penumbral" period commences and concludes the eclipse, and this portion of an eclipse is either invisible or barely visible. The umbral portion of this eclipse commenced almost exactly ninety minutes later, at 1:38 a.m. on the morning of March 13. The eclipse reached its maximum totality about an hour later, at 2:42 a.m., *but was only 36% total at the time of maximum totality*. The eclipse then receded for another two and a half hours or so, concluding at around 5 a.m.

This is a puny eclipse. Having seen several dozen in my life, I know from experience that at this level of totality, the moon is still bright; it simply has a smudge in its corner. There is no reddening of the moon, characteristic of deep eclipses, at this minor level of totality. It is a fact that in all of his writings, the eclipse which preceded Herod's death is the only eclipse Josephus ever mentioned. But what a meek little eclipse it was—if, indeed, this is the correct eclipse. Furthermore, as Pratt notes in his paper, few, if any, souls in the ancient Jerusalem of 4 BC would even have been awake to behold this eclipse. Given that this eclipse was insignificant, and moreover seen by next-to-nobody, it is highly unlikely that any memory of this eclipse would have survived for over 75 years by word-of-mouth, to be eventually noted by Josephus as shortly preceding the death of Herod.

Given all of the problems associated with the March 13, 4 BC, eclipse, W. E. Filmer proposed the eclipse of January 10, 1 BC, as the eclipse associated by Josephus with the death of Herod.²⁰ Since this eclipse occurred a full three months before Passover, it solves all the chronological difficulties presented by

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the eclipse of March 13, 4 BC, giving ample time for all the events that occurred between the time of the eclipse and Herod's death, and its aftermath. Furthermore, unlike the barely noticeable eclipse of March 13, 4 BC, this eclipse was more visible, and would have been worth remembering and reporting decades later to Josephus—if, however, anybody had actually seen the eclipse. This eclipse, too, suffers from the same problem that plagued the eclipse of March 13, 4 BC: it happened when almost everyone would be asleep.

Here is the *ephemeris* for the January 10, 1 BC eclipse:

First penumbral contact:	10:31 p.m. (January 9, 1 BC)
First umbral contact:	11:28 p.m.
Total eclipse:	12:25 a.m. (January 10)
Maximum totality:	1:15 a.m.
End of totality:	2:05 a.m.
Last umbral contact:	3:03 a.m.
Last penumbral contact; eclipse over:	4:00 a.m.

This eclipse would have begun to be visible between 11:00–11:30 p.m. That is two to three hours better than the 1:38 a.m. or so of the eclipse of March 13, 4 BC. But that benefit is likely cancelled by the fact that the January 10 eclipse occurred at a time of the year when the sun went down (5:05 p.m.) a full fifty minutes earlier than it did on March 13, 4 BC (5:54 p.m.). This eclipse of January 10, 1 BC, became palpably visible about 6.5 hours after sundown, whereas the March 13, 4 BC, eclipse became palpably visible about 7.5 hours after sundown. In a time and place where people generally retired at darkness, there is little real difference between the timing of these eclipses; both would have been seen by few people. This is particularly true in January, when the nights even in Judea are markedly colder than they are in March.

There was another eclipse on September 15, 5 BC, which Barnes, at least, believed was the eclipse which Josephus said preceded the death of Herod:²¹

First penumbral contact:	7:46 p.m. (September 15, 5 BC)
First umbral contact:	8:44 p.m.
Total eclipse:	9:44 p.m.
Maximum totality:	10:34 p.m.

End of totality:	11:23 p.m.
Last umbral contact:	12:22 a.m. (September 16)
Last penumbral contact; eclipse over:	1:22 a.m.

This eclipse began to become palpably visible a couple of hours or so after sundown. But few people other than Barnes have ever believed that this was the eclipse Josephus spoke about. It would date the death of Herod too early for other accounts.

Finally, we arrive at the eclipse of December 29, 1 BC, which Pratt argues was the eclipse which preceded the death of Herod.

Here is the *ephemeris* of that eclipse:

First penumbral contact:	2:20 p.m. (December 29, 1 BC; during the day, before moonrise, when the moon was still below the horizon, and invisible.)
First umbral contact:	3:28 p.m. (moon still invisible)
Maximum % of totality:	4:44 p.m. (moon still invisible; moon is under a 57% partial eclipse)
Time of complete moonrise:	5:02 p.m. (moon is visible and 53% eclipsed)
Last umbral contact:	5:59 p.m.
Last penumbral contact; eclipse over:	7:07 p.m.

While it was not a total eclipse, it is actually a highly eye-catching event to see an expectant full moon rise misshapen and eclipsed. Pratt reasons that the dramatic nature of seeing a full moon rise under eclipse is dramatic and startling; it seldom happens, and people therefore tend to remember it. Due to the striking nature of this eclipse, and due to the fact that it occurred at a time when many people must have witnessed it, it would be a memorable occasion, and from then on, used to date other events. Pratt very reasonably believes the partial eclipse of December 29, 1 BC, was the eclipse that Josephus says preceded and heralded the death of Herod. As does the eclipse of January of that year, this eclipse, too, occurs three months before Passover, allowing enough time for the various events to happen which had to occur between the Josephus eclipse and the

following Passover. If so, then Herod died early in AD 1, and Jesus therefore was born in 1 BC or 2 BC.²²

There are some problems left to resolve: Who was governor of Syria at the time of the census of the Nativity? And how well does this harmonize with Matthew's account of the infant Jesus being born before Herod died? And what about Josephus statements that the sons of Herod (other than the executed Antipater) came into their tetrarchies in 4-3 BC, implying, as this does, that Herod died in 4 BC after all?

See Tables 146 and 147 below, found in Jack Finegan's *Handbook of Biblical Chronology*, both of which give listings of the governors of Syria from 9 BC-AD 7.²³ Gaius Caesar died in Syria in AD 4, so even if Table 147 does not mention his replacement, it is reasonable to suppose that L. Volusius Saturninus replaced him until AD 6.

Josephus said that Varus was governor of Syria when Herod died. Looking at the tables, we see

general agreement that Varus began being governor in 6 BC and this continued into 4 BC. But then, in Table 147, there is a notation that Varus was also governor in 1 BC. Since this does not appear in Table 146, what does its appearance in Table 147 mean? Why is it in Table 146 but not in the other table, and can we trust it? The usually accepted list of governors is from the Schürer-derived Table 146.²⁴ Thus we are left with Varus as governor (who Josephus said was governor when Herod died and therefore after Jesus was born) if Jesus was born in 4 BC, or with Quirinius as governor if Jesus was born in 3 BC or 2 BC.

But what about Varus? A stone with an inscription was found near his old manor in 1784, referring to a certain unnamed man who was twice governor of Syria.²⁵ Knowing that Varus was governor of Syria at least once, whom else could this refer to but Varus? But if so, when? If Quirinius was governor when Augustus called for the census and when Herod was still alive—but if Varus was governor

Year	Name of Governor, Table 146	Name of Governor, Table 147
9 BC	M. Titius	M. Titius
8 BC	C. Sentius Saturninus	Titius
7 BC	C. Sentius Saturninus	Titius, then P. Q. Varus
6 BC	Saturninus, then P. Q. Varus	P. Quintilius Varus
5 BC	Varus	Varus
4 BC	Varus	Varus, then C. S. Saturninus
3 BC	P. Sulpicius Quirinius	C. Sentius Saturninus
2 BC	Quirinius	C. Sentius Saturninus, then Varus
1 BC	Gaius Caesar	Varus
AD 1	Gaius Caesar	Varus, then Gaius Caesar
AD 2	Gaius Caesar	Gaius Caesar
AD 3	Gaius Caesar	Gaius Caesar
AD 4	G. Caesar, then L. V. Saturninus	Gaius Caesar
AD 5	L. Volusius Saturninus	
AD 6	Quirinius	
AD 7	Quirinius	

Tables 146 and 147 of Jack Finegan's *Handbook of Biblical Chronology* listing the governors of Syria from 9 BC to AD 7.

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when Herod died—that means Varus could *not* have followed Quirinius as governor after Quirinius stepped down after AD 7, because Herod was long dead even before AD 6. And furthermore, after AD 7, Varus was involved with the legions in Germany, where he and three legions were destroyed in AD 9.

Luke and Josephus could agree if both Quirinius and Varus were each governor for two periods. That scenario fits with the evidence of the *Lapis Tiburtinus*. According to Schürer, Varus was governor in 4 BC and was succeeded the following year by Quirinius (see Table 146), who therefore was governor of Syria for *both* of the *censi* which Augustus called for the Holy Land, one in 2 BC to affirm him as *Pater Patriae*, and the other in AD 6 after Rome deposed Herod Archelaus and annexed and governed Judea directly.

This means that the order of Roman governors was Varus (4 BC) / Quirinius (3 BC and 2 BC) / Varus again—but wait a minute here; we also know that Gaius Caesar became governor in 1 BC, so how could Varus *possibly* have been governor a second time—the *Lapis Tiburtinus* notwithstanding? The answer may lie with considering who Gaius Caesar was. Gaius Caesar was Emperor Augustus's beloved and oldest living grandson. He was currently the heir apparent, expected to become emperor after Augustus died. He was *royalty*. Josephus says that Gaius Caesar was in Rome after Herod died; this would seem to make perfect sense, since Caesar was one of the two consuls for the year AD 1, although certain Roman sources say Caesar was made governor of Syria in 1 BC.²⁶ This objection is really no objection at all, because there is no reason why he could not have been both.

Robert Graves notes that while Caesar was on his way to his station in Syria, he stopped on Chios, met his step-uncle Tiberius, and agreed to take a letter back to Rome for Tiberius²⁷—this would mean that he returned to Rome immediately and did not actually arrive at his duty-station. Dio Cassius notes that the Parthians came to terms with the Romans in AD 1,²⁸ thus making the governorship of Syria an easy, peaceful one, thereby allowing Caesar to slip back home to Rome for a visit, and to resume his other duties as consul. Absentee governors were tolerated if they were important enough. A few decades previously, Pompey had been an absentee

governor of Spain for several years, and he was allowed to rule his province from Rome, sending out viceroys to govern in his absence.

Knowing that Gaius Caesar was a consul of Rome as well as governor of Syria in AD 1 (which meant he had official duties in Rome also) and knowing that he did return to Rome at least once, it is easy to place him in Rome after Herod died. So this then begs the question: when Gaius Caesar was not minding the shop in Syria, who was? At this point, Publius Quintilius Varus comes into the picture *twice* as governor of Syria: the first of those times was after 4 BC, according to the *Lapis Tiburtinus*, and the second time was as acting governor of Syria when Herod died, to believe Josephus. He must have substituted for the sometimes absent Gaius Caesar (who, in addition, was hardly twenty years old; Augustus would not have objected to having an *experienced* governor while his stripling grandson gallivanted back and forth). It all fits together.

Finally, we have the small matter of dealing with Josephus's *seeming* to state that the surviving sons of Herod assumed their tetrarchies in 4 BC after he died. Pratt has already discussed the reasonable possibility of antedating their regnal years.

But there is an even stronger argument against Josephus's assertion—the witness against Josephus, again, being Josephus himself, or rather the variant versions of Josephus. In *Antiquities*, Josephus states that Herod Philip died in the twentieth year of the reign of the emperor Tiberius, after having served as tetrarch for 37 years.²⁹ Since Tiberius came to power in AD 14; this places Philip died in AD 33 or AD 34, which places the commencement of his tetrarchy in 4 BC or 3 BC. However, Finegan writes as follows:³⁰

Already in the nineteenth century Florian Riess reported that the Franciscan monk Molkenbuhr claimed to have seen a 1517 Parisian copy of Josephus and an 1841 Venetian copy, in each of which the text read “the twenty-second year of Tiberius.” The antiquity of this reading has now been abundantly confirmed. In 1995 David W. Breyer reported to the Society for Biblical Literature his personal examination in the British Museum of forty-six editions of Josephus’ *Antiquities* published before 1700, among which twenty-seven texts, all but three published before 1544, read “twenty-second year of Tiberius,” while not

a single edition published prior to 1544 read “twentieth year of Tiberius.”³¹ Likewise, in the Library of Congress, five more editions read the “twenty-second year,” while none prior to 1544 records the “twentieth year.” It was also found that the oldest versions of the text give various length of reign for Philip of 32 and 36 years. But if we allow for a full thirty-seven year reign, then “the twenty-second year of Tiberius” (AD 35/36) points to 1 BC ... as the year of the death of Herod.³²

Summary of the Argument

The date of Jesus’s birth has long been thought to have been at sometime from 6 BC to 4 BC, based solely on Flavius Josephus, who reported that a lunar eclipse shortly preceded King Herod’s death, and we do know a lunar eclipse occurred on March 13, 4 BC. However,

1. Josephus himself contradicts his own dates repeatedly, leaving us uncertain about *all* of his dates.
2. Different versions of Josephus exist which add to the uncertainty, in that they give different years for the death of one of Herod’s sons, which therefore casts into question whether they began their tetrarchies in 4 BC or in 3 BC. Furthermore, there is reason to suppose that they intentionally antedated when their tetrarchies commenced, for political credibility.
3. Publius Quinctilius Varus appears to have been twice the governor of Syria, one of those times after 4 BC. Josephus says he was governor when Herod died. Since he could not have been governor in 3 BC or in 2 BC, this leaves him perhaps as a sometimes viceroy, filling in for the sometimes absent Governor Gaius Caesar starting in 1 BC, the date therefore of Herod’s death.
4. There were *two* Roman *censi* in the final decade of the BC era. One was in 8 BC. This was not the census mentioned in the Gospel of Luke, because according to Luke, Quirinius was not the governor of Syria in that year, and because this census counted only Roman citizens; the Holy Family, like almost all residents of Judea, were not Roman citizens and so would not have been affected by this census. However, the census/registration which occurred in 2 BC as a consequence of the

Senate and Roman people naming Caesar Augustus the *Pater Patriae*, the “Father of the Country,” *would* have affected the residents of the Holy Land, since all were required to affirm Augustus in his title. In any event, since Herod did not die shortly after 8 BC, and since he did die after a census, therefore he could not have died in 4 BC, when there was no census.

5. Most of the ancient sources reported that Jesus was born between 3 BC and AD 1.
6. Josephus said that Herod captured Jerusalem and executed his rival for the Jewish throne on the Day of Atonement, the exact anniversary of the capture of Jerusalem by Pompey 27 years earlier, that is, in 63 BC; this means that even if Herod reigned for only 34 years thereafter (and not 37 years), he therefore must have died in 2 BC or 1 BC.
7. The lunar eclipse of March 13, 4 BC, may be disregarded as the herald of Herod’s death because it was nothing more than a minor partial eclipse, which furthermore appeared at a very late hour when next-to-nobody would have seen it. It was not a sufficiently memorable occasion for public recollection.
8. Since there were no lunar eclipses in 3 BC or 2 BC, but there were two in 1 BC, one of these eclipses *has* to be the eclipse which Josephus says heralded the death of Herod. The first eclipse occurred on January 10, 1 BC, and was a full-blown total eclipse of the moon. While this eclipse is suitable because of its grandeur and because it gives three months between its occurrence and Passover, this eclipse is unlikely to be the eclipse of Josephus because it occurred at a later hour. It also was at a time of the year when people went to bed even earlier than at other times of the year, and moreover it was cold at night in Jerusalem, which would tend to reduce even more the number of viewers.
9. This leaves us with the partial eclipse of December 29, 1 BC, twelve lunar months later. In terms of allowing enough time for certain significant events to occur (again, three months before Passover), this eclipse is ideally suited to be Josephus’s eclipse in that the full moon that rose that night was already under half-umbral eclipse

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when it was first seen at sunset, thereby assuring that many people would have noticed it, many more than the eclipse of January 10.

10. This remembered eclipse is the most likely one that Josephus had in mind as heralding the death of Herod. Granted that aside from the issue of how many people saw it, the other 1 BC eclipse might fit the descriptions too.

11. Finally, the major gap in the Gospels separating Luke's account from Matthew's account has been resolved and eliminated. We have long supposed that Luke's gospel requires Jesus to have been born after AD 6, whereas Matthew's gospel requires Jesus to have been born between 6 BC and 4 BC. However, thanks to understanding Josephus's errors and understanding more about the *Pater Patriae* registration of the entire Roman Empire in 2 BC, this allows us to bridge the 10-12-year gap between Matthew and Luke by moving Luke's timeline back eight years from the typical dating and moving forward Matthew's timeline by 4-6 years from the most common description, actually causing them to meet and indeed overlap.

Conclusions

- King Herod died, not in 4 BC as commonly believed, but either early in 1 BC before Passover, or early in AD 1, again before Passover.
- If Herod died in 1 BC, Jesus was born between 3 BC and 1 BC.
- If Herod died in AD 1, Jesus was born between 2 BC and AD 1.
- The *Pater Patriae* registration of all inhabitants of the Roman Empire initiated in 2 BC (and not the popularly believed census of Palestine taken in AD 6) is the census which Luke reported as having occurred when Quirinius was governor of Syria; he was governor in 2 BC and again in AD 6. It should also be noted that Luke did *not* say that Quirinius was governor when Herod died; only that he was governor at the time the *Pater Patriae* registration was ordered (and Herod presumably was still alive). Furthermore, when Luke reported that the census was of the entire (Roman) world, we now see that he did not exaggerate, if we regard the *Pater Patriae* census of 2 BC and not Quirinius's

local census of AD 6 as the census he was talking about. The streams of evidence resolve: Jesus was probably born sometime in 2 BC. ★

Notes

¹There is no such a thing, of course, as the "Year 0." There is 1 BC (Before Christ) which is immediately followed by AD 1 (*Anno Domini*, Latin for "the year of the Lord").

²Irenaeus, Against All Heresies in *The Ante-Nicene Fathers: Translations of the Writings of the Fathers down to AD 325*, 10 vols. (1885–1887; reprint, Peabody, MA: Hendrickson, 1994), 3.21.03.

³Clement of Alexandria, Stromata, in *The Ante-Nicene Fathers* 3, 151, note 1.

⁴Eusebius, *The History of the Church*, trans. G. A Williamson (New York: Dorset Book edition, 1965), Book 1, 5.5.

⁵Jack Finegan, *Handbook of Biblical Chronology* (Peabody, MA: Hendrickson Publishers, 1998), 302, Table 146, who cites Emil Schürer, *A History of the Jewish People in the Time of Jesus Christ*, 5 vols. (New York: Scribner's, 1896); G. Vermes and F. Millar, 3 volumes in 4, rev. ed. (Edinburgh: T&T Clark, 1973–1987), vol. 1.1, 350–7; *Realencyclopädie der classischen Altertumswissenschaft* (Real Encyclopedia of Classical Ancient Knowledge), Zweite Reihe (2nd Row), 4.2, col. 1629.

⁶Flavius Josephus, *Jewish Antiquities* Book 18, paragraphs 1–2 in Loeb Classical Library, No. 433, trans. L. H. Feldman, (Cambridge MA: Harvard University Press, 1963), 12.

⁷Josephus, *Antiquities* 18.4.

⁸Schürer, *A History of the Jewish People in the Age of Jesus Christ*, 1.257.

⁹Ernest L. Martin, *The Star That Astonished the World*, 2nd ed. (Portland, OR: Associates for Scriptural Knowledge, 1991), 174–9, 232–4. He writes about the Lapis Tiburtinus, the stone found near what was Publius Quinctilius Varus's estate outside Rome.

¹⁰Josephus, *Antiquities* 17.2.1; 17.5.2.

¹¹Josephus, *Antiquities* 14.16.4 (year specified by the two consuls); 17.6.4; 17.8.1; 17.8.2; 18.2.1; 18.4.6. A pair of men always served a one-calendar-year term as consuls of Rome, and careful records were kept of who was consul in what year. Matching an event with the time of the consulships of X and Y is therefore a very solid way of dating that event.

¹²John P. Pratt, "Yet Another Eclipse for Herod," *The Planetarian* 19, no. 4 (Dec. 1990): 8–14 (emphasis added). The paper is also available from Dr. Pratt's own website www.johnpratt.com.

¹³Timothy D. Barnes, "The Date of Herod's Death," *The Journal of Theological Studies* 19 (1968): 204–9.

¹⁴Ernest L. Martin, *The Birth of Christ Recalculated* (Pasadena, CA: Foundation for Biblical Research Publications, 1980).

¹⁵Josephus, *Antiquities* 14.389; 14.487; 17.191.

¹⁶Babylonian Talmud Tractate Rosh Hashanah, 10b.

¹⁷Josephus, *Antiquities* 14.389; 14.487; 17.191.

¹⁸Pratt, "Yet Another Eclipse for Herod," 3.3 in the online version, <http://www.johnpratt.com/items/docs/herod/herod.html>.

¹⁹For astronomical information, I have used a program throughout this book called *Skylights*, written and

copyrighted in 1994 by G. Vecchi, and sold by Zephyr Services of Pittsburgh, PA. Jerusalem Local Time, when the position of the sun is at its zenith, is defined as 12 o'clock High Noon. All stated times are relative to this reference.

²⁰W. E. Filmer, "The Chronology of the Reign of Herod the Great," *The Journal of Theological Studies* 17 (1966): 283–98.

²¹Barnes, "The Date of Herod's Death," *The Journal of Theological Studies*, 204–9.

²²Pratt, "Yet Another Eclipse for Herod," 2.5.

²³Jack Finegan, *Handbook of Biblical Chronology*, 302, 304.

²⁴Schürer, *The History of the Jewish People in the Age of Jesus Christ*, 1.257.

²⁵Martin, *The Star That Astonished the World*, 174–9, 232–4.

²⁶Josephus, *Antiquities* 17.9.5; Dio Cassius from E. Cary, *Dio's Roman History* (Cambridge, MA: Harvard University, 1980), 40.9–10.4; Barnes, "The Date of Herod's Death," 208.

²⁷Robert Graves, *I Claudius: From the Autobiography of Tiberius Claudius, Born 10 BC, Murdered and Deified AD 54* (New York: Vintage Books, 1989), 81.

²⁸Dio Cassius 40.10.4.

²⁹Josephus, *Antiquities* 18.106.

³⁰Finegan, *Handbook of Biblical Chronology*, 301.

³¹Filmer, "The Chronology of the Reign of Herod the Great," 298; Barnes, "The Date of Herod's Death," 205; Riess, *Das Geburtsjahr Christi (The Year of Jesus' Birth)* (Freiburg: Herder, 1880); David W. Beyer, "Josephus Re-examined: Unraveling the Twenty-Second Year of Tiberius," in *Chronos, Kairos, Christos II*, ed. E. Jerry Vardaman (Macon, GA: Mercer University Press, 1998).

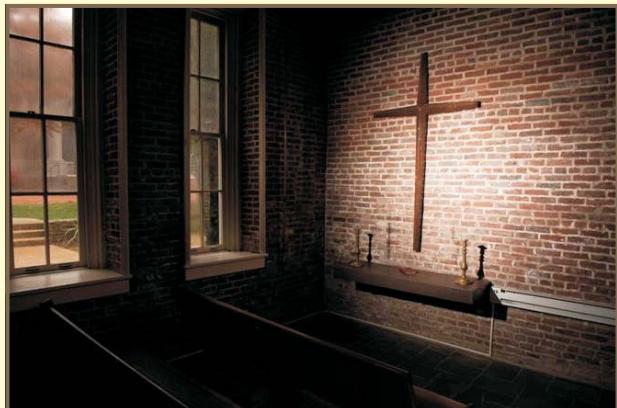
³²Beyer, "Josephus Re-examined," 4.

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Keith B. Miller

Article

The Nature of Science and the Public Debate over Anthropogenic Global Warming

Keith B. Miller

Misconceptions about the nature of science, and a lack of understanding of how the scientific community evaluates evidence and reaches consensus, distorts the public evaluation of anthropogenic global warming.

There are several popular misconceptions about the nature of science that underlie the resistance of much of the public to climate change science. These misconceptions also underlie the public response to other conclusions of the scientific community, such as biological evolution.¹ Common misconceptions include the following: (1) an emphasis on “facts” and a demand for “proof”; (2) a view of theories that equates them with unsubstantiated guesses; (3) a strong discomfort with uncertainty and unresolved questions; (4) a failure to recognize the importance of scale and context in recognizing trends and formulating explanations; and (5) a rejection of scientific consensus because it is perceived as politically or philosophically motivated. It is critical that these problems be explicitly addressed when communicating climate science. Otherwise, the public debate will be framed not by the evidence, but by faulty views of science itself.

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Fact and Theory in Science

A common public misconception is that science is a search for unchanging scientific “facts.” However, if “fact” means an objective statement of the true nature of the physical universe, there are very few “facts” in science. The closest thing to “facts” in science are the observations upon which our understanding of the natural world is built. However, our observations are themselves subject to bias and error. More importantly, our observations are always limited. Our descriptions cannot be exhaustive—we must choose what to observe. Observations are driven by the questions being asked, and are made in a particular context. They are also dependent on expectations and the available tools. The limits of individual observation explain why science demands repeated and independent confirmation of observational results (whether direct or experimental). This also explains why the diversity of the scientific community—across disciplines, cultures, and worldviews—is critical to its success.

Science is not the encyclopedic accumulation of “facts.” Observations (data) by themselves have little meaning or

utility. Meaning and explanation require the recognition of the consistent patterns in our observations. We can understand our natural world only to the extent that it behaves in regular, predictable ways. Much of the doing of science involves discovering these patterns. It is these regularities in the natural world that suggest underlying consistent causes, and constructing causal explanations for patterns of observations is generating a scientific theory.

Scientists and nonscientists typically use the word “theory” in very different ways and in different contexts. In common parlance, “theory” often means an unsubstantiated guess. However, scientific “theories” are not guesses, but are natural cause-and-effect explanations for the regularities we observe in the natural world around us. Theories integrate diverse independent observations by recognizing patterns and trends within the data that give those observations meaning. The construction of theories is the essence of science, and its power as a methodology.²

A prominent source cited by climate skeptics illustrates the misconstrued role of observations and theories in science. *The Skeptics Handbook* states:

[Computer models are] sophisticated, put together by experts, and getting better all the time. But even if they could predict the climate correctly (they can't), even if they were based on solid proven theories (they aren't), they still wouldn't count as evidence. Models of complex systems are based on scores of assumptions and estimates piled on dozens of theories.

...

Science depends on observations, made by people at some time and place. Things you can see, hold, hear, and record.³

Notice that theories and models are not perceived as providing a basis for supporting, or refuting, our current understanding of climate processes. Only “observations” seem to qualify as evidence. But this ignores the fact that observations in isolation are without meaning. The denigrated “theories” and “models” are simply the expression of the patterns that are seen in the observational data, combined with our current understanding of physical processes. Theories are the only way to understand the observations, and they provide the basis for prediction and testing. It is the ability of theories to predict future

observations that makes them such powerful tools. Testing our theoretical understanding against new observations is also the only way to find errors and advance our knowledge of the natural world. Theories extend our reach beyond what is currently known and generate expectations for future discoveries. They are how we gain new insights into nature. Without theories, we have nothing.

It is also significant that the quote above stresses that the theories are not “proven.” This again fails to understand the nature of explanatory theories. Even the most powerful and unquestioned theories are not “proven” in any absolute sense. Theories are held with varying degrees of confidence based on their explanatory and predictive power. The common demand for proof is related to a failure to understand the role of uncertainty in science.

Misunderstanding Uncertainty

There are several different types of uncertainty in science. There is the uncertainty that results just from the limits of precision with which we are capable of measuring things. This is expressed in terms of significant figures or ranges of error in numerical values. Then there is the uncertainty that results from inherently random (or stochastic) processes that are described in terms of probability. One of the common misconceptions of random processes is that they are haphazard and without any coherent pattern. However, as with the flipping of a coin, or the rolling of dice, the behavior of a system can be predicted quite accurately after many trials even when the outcome of an individual event cannot be predicted. Lastly, there is the uncertainty that results from the inherently incomplete understanding of physical reality that is present in any theory. Because our knowledge is always incomplete, scientific theories will always be accompanied by some degree of uncertainty. This means that conclusions in science are always held tentatively.

A problem in communicating the conclusions of science is that many people are very uncomfortable with uncertainty. The language of science, with talk of probabilities and likelihoods, conflicts with the desire for confident assurance and certainty. Furthermore, when scientific conclusions require fundamental shifts in previous views or imply a costly

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response, people typically demand a level of certainty, or “proof,” that science cannot provide.

Certain scientific theories are widely held, not because they are “proven,” but because they are able to provide testable explanations for a wide range of observations. They bring many seemingly unrelated observations under a unified explanatory umbrella. It is the weight of the total body of available evidence, not the agreement of every individual observation, that causes a theory to be accepted or rejected. Scientific consensus (though never unanimity) can only be obtained when the available evidence overwhelmingly supports a particular interpretation.

The following statement from *A Cool Look at Global Warming* argues for a rejection of action to reduce CO₂ emissions because of a perceived possibility of error in the scientific conclusions.

The earth’s atmosphere may be warming, but if so, not by much and not in an alarming or unprecedented way. It is possible that the warming has a “significant human influence,” to use the IPCC’s term, and I do not dismiss the possibility. But there are other powerful possible causes that have nothing to do with us. If this were simply an example of scientists arguing among themselves we might recognize that this is how science proceeds, and move on. But if there is no true causal link between CO₂ and rising temperatures, then all the talk about carbon caps and carbon trading is simply futile. But it is worse than futile, because one consequence of developing policies in this area will be to reduce not only our own standard of living but the standard of living of the world’s poorest countries.⁴

Contrary to the doubts expressed above, there is a demonstrable causal link between increasing CO₂ and increased surface temperatures. However, there is uncertainty in the rate and magnitude of the temperature rise, and its regional and global effects. The quotation above is really reacting to two kinds of uncertainty in climate science. One is the uncertainty that results from our incomplete knowledge of all relevant climate feedbacks, and the other results from the inherent randomness of the atmospheric system that requires forecasts to be made in terms of probability. The latter uncertainty would still be present even if we had complete knowledge of all of the relevant physics.

The argument made above is that if a scientific theory cannot be proven (or if it cannot predict certain outcomes with certainty), then it is unwise to act on its implications. This not only fails to recognize that no theory in science is absolute, but also that every one of us regularly makes decisions in the absence of certainty. In fact, we regularly make life-and-death decisions in the absence of certainty. The emphasis should not be on waiting for the scientific community to reach some unattainable standard of proof, but to act on the best current understanding of the available evidence. Also, it must be recognized that to fail to act is itself an action with potential consequences. We are acting on incomplete knowledge regardless.

Importance of Scale and Context

Any processes will act only within a particular range of time scales. Thus, any observed trend can only be understood by reference to the processes that are important on time scale represented by the trend. The importance of a time scale can be illustrated by reference to a familiar set of data—the stock market. Trends in stock market prices can be analyzed over a range of time scales from a single day to weeks, months, and years. The observed trends in the data would have different explanations at different time scales. Different market forces act at different time scales. The explanation for a trend on one time scale is unlikely to be applicable at another. Processes of the earth/climate system similarly act over different time scales.

The recognized patterns and trends in observations that undergird scientific theories are nearly always scale dependent. Trends can be recognized and understood only in the context of a particular temporal and spatial scale. The causal agents involved at different temporal and spatial scales will almost always be different—at least in importance if not in kind. It is thus critical that the scales being discussed be made explicit. Public discussions of both evolution and climate change are often made without any reference to the relevant scale. In the case of climate change, this often expresses itself in the confusion of human and geological time scales.

Some of the major drivers of climate change, and important feedback mechanisms, are listed in table 1.

The time scales over which these driving and feedback mechanisms act are also shown. What is critical for the current discussion is that the plausible mechanisms for climate change vary with the time scales under consideration. The discussion of potential causes for climate change must always be undertaken within the context of a particular temporal scale.

The misapplication and misunderstanding of the role of scale is common in the public discussion of climate change. A few years back there was very frequent mention that there had been no global warming for a decade, or even that global average temperatures had declined. A typical example of such a claim is quoted below:

Global-warming activists insist that we can't take an assumption from a single year. However, if the CWS forecast turns out to be correct, we will have gone *eleven* years without any warming at all—eleven years in which carbon emissions did

not decline in any significant manner. How does one begin to explain that? And how will Kerry and Boxer and the rest of their Democratic colleagues try to sell cap-and-trade as a scientific necessity while people spend a fortune heating their homes in the coldest winter in a decade?⁵

The decade-long interval mentioned above is part of a century-long trend of increasing global temperatures. The long-term trend is a consequence of a multitude of driving forces and feedback processes, each acting at different time scales. Any multidecadal trend is going to be “noisy.” Short-term trends will not necessarily reflect long-term ones. Furthermore, the years in question represent a time of declining solar irradiance occurring as part of a cyclical change in solar activity. Despite low solar irradiance, nine of those eleven years were still among the ten warmest years in the modern instrumental record up to that time (see fig. 1). That long-term trend has continued in subsequent years with nine of the ten warmest years occurring since 2001.⁶

	Solar Radiation	Plate Tectonics	Ocean Circulation	Atmospheric Composition	Albedo	Anthropogenic Causes
Billions of Years	Increase in solar radiation during lifetime of Sun.			Oxidation of the oceans and atmosphere.		
Tens to Hundreds of Millions of Years		Change in continental positions.	Changing shape and connections of ocean basins.			
Millions to Tens of Millions of Years		Change in continental positions and uplift of mountains.	Changing shape and connections of ocean basins. Disruption of thermohaline circulation, and ocean stratification.	Carbon storage in organic deposits (e.g., coal, shale) and in limestones. Removal of CO ₂ during accelerated rates of chemical weathering.		
Tens to Hundreds of Thousands of Years	Milankovitch orbital variations in intensity and seasonal distribution of solar radiation.		Disruption of thermohaline circulation and ocean stratification.	Generation of CO ₂ during formation of major volcanic provinces. Absorption and release of CO ₂ from ocean. Terrestrial and ocean sediment carbon storage and release.	Growth and retreat of large continental ice sheets.	
Tens to Hundreds of Years			Large freshwater outflows into North Atlantic. Rapid disintegration of ice shelves (Heinrich events).	Melting of permafrost and ocean floor methane ices.	Change in seasonal extent of sea ice.	Release of CO ₂ from burning of stored carbon (“fossil fuels”) and deforestation.
Years	Sun spot cycles		El Niño and La Niña oscillations. North Atlantic oscillation.	Individual volcanic eruptions (release of H ₂ S or CO ₂).		

Table 1. This table summarizes some of the major forcing and feedback mechanisms that determine global climate. These mechanisms act to cause changes in the global climate at different time scales. The columns of the table group climate mechanisms by type, and the rows represent the different temporal scales over which the mechanisms act, from years to billions of years.

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The quote above also mentions the unusually cold winter of 2009–2010. Aside from the error of using single data points to refute a long-term trend, there is also the problem of spatial scale. Those cold winter temperatures occurred in North America, northern Europe, and central Asia. However, at the same time, the arctic was well above average in temperature, and much of the rest of the world was warm as well. Despite the regional cold during the northern hemisphere winter, 2010 was globally the warmest year in the instrumental record according to the Goddard Institute for Space Studies. Particular extreme weather events, or records, are much more likely to be noticed and remembered than long-term trends.⁷

The tendency to emphasize individual data points at the expense of long-term trends is also illustrated in the quotation below:

On a global basis, world sea ice in April 2008 reached levels that were “unprecedented” for the month of April in over 25 years. Levels are the third highest (for April) since the commencement of records in 1979, exceeded only by levels in 1979 and 1982. This continues a pattern established earlier in 2008, as global sea ice in March 2008 was also the third highest March on record, while January 2008 sea ice was the second highest January on record. It was also the second highest single month in the past 20 years (second only to Sept 1996).⁸

Citing of such single-month “records” seems to assume that for anthropogenic global warming to be

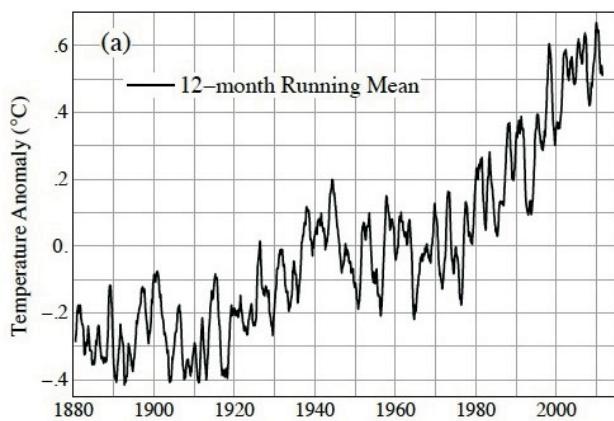


Figure 1. Global surface temperature anomalies over 120 years using data from four different sources. Image credit: Robert Simmon, NASA Earth Observatory. (“Despite subtle differences, global temperature records in close agreement,” posted January 13, 2011, <http://www.giss.nasa.gov/research/news/20110113/>).

true, all climate-related observations must proceed according to invariant trends. Thus any deviation from a consistent trend is viewed as evidence against global warming. But because the global climate at any point in time is the result of many processes acting over a wide range of temporal and spatial scales, trends will always be statistical patterns averaged over many years. The actual global ice extent data (including both Arctic and Antarctic sea ice) that was the basis of the quotation above is shown in figure 2. In the Arctic, where sea ice loss has been most dramatic, maximum sea ice extent in 2008 did not even approach the long-term 1972–2008 average. Figure 3 shows the long-term trend in Arctic sea ice extent since the 1950s.

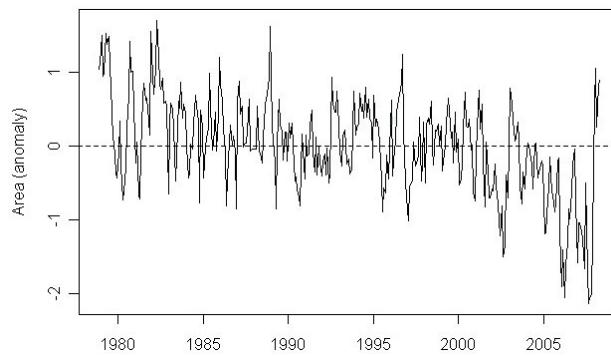


Figure 2. Global ice extent including both Arctic and Antarctic sea ice. (Steve McIntyre, “Southern Hemisphere Sea Ice Reaches ‘Unprecedented’ Levels” [May 4, 2008], <http://climateaudit.org/2008/05/04/world-sea-ice-reaches-levels-unprecedented-in-25-years/>).

Arctic Sea Ice Extent Standardized Anomalies
Jan 1953–Dec 2011

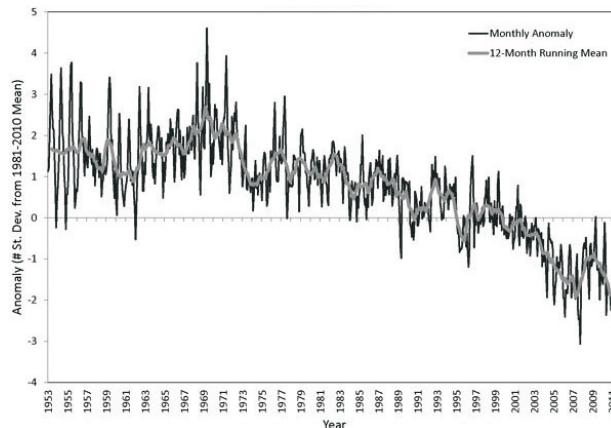


Figure 3. Arctic sea ice extent showing monthly anomalies and yearly running means. Reproduced from the National Snow and Ice Data Center. Image by Walt Meier and Julienne Stroeve, National Snow and Ice Data Center, University of Colorado, Boulder. (http://nsidc.org/cryosphere/sotc/sea_ice.html).

Not only must temporal scales be kept in mind, but also spatial scales. Regional or local events may not follow global trends. In fact, as we have seen with the example of the cold North American winter of 2009–2010, global climate change does not mean globally uniform or invariable change. Nonetheless, people often cite specific local changes as overturning long-term global trends. As an example,

Glaciers are growing in the Himalayan Mountains, confounding global warming alarmists who have recently claimed the glaciers were shrinking and that global warming was to blame. A new study of the Karakoram, Hindu Kush, and Western Himalaya mountain ranges by researchers at England's Newcastle University shows consistent recent growth among the region's glaciers.⁹

Determining the behavior of mountain glaciers is very difficult without direct observation and mass balance calculations (determining the difference between snow accumulation and snow/ice melt). Such work has been done for many glaciers in North America, Europe, and the former Soviet Union. Analysis of this mass balance data shows that the global trend for mountain glaciers is one of accelerated ice loss despite increases in annual snow accumulation.¹⁰ Figure 4 shows average annual glacial thickness changes from this data. In the Himalayas, where

mass balance data is largely not available, most reports on glacier fluctuations are based on satellite- and ground-based observations of terminus location. On the basis of current data, there are some glaciers in the Himalayas that appear to be advancing, but most are retreating.¹¹ Whatever the final conclusions for the Himalayan region, all glaciers would not be expected to behave the same way given the many local and regional factors that can control snow accumulation and melt rates. Again, it is the global average patterns that are significant.

Even beyond the issue of scale is one of appropriate context. The question of the likely extent of anthropogenic climate change, and the debate over appropriate societal responses, must be addressed within the context of our modern industrialized society. The following statement attempts to consider future global warming completely divorced from consideration of its impact on modern societies—in fact, divorced from the consideration of the existence of humanity at all.

Atmospheric carbon dioxide is at higher levels than at any time in the past 650,000 years. Yes, but if we go back 500 million years, carbon levels were not just 10–20 percent higher, they were 10–20 *times* higher. The earth has thoroughly tested the runaway greenhouse effect, and *nothing* happened.¹²

This argument is surprisingly quite common. The general point seems to be that global temperatures (and CO₂ levels) have been much higher in the geologic past, and therefore modern climate change need not be viewed as extraordinary, or of special concern. The earth has indeed been much warmer than today at several periods during its past history. There have been times in the geologic past when no permanent glacial ice was present at the poles, and forests extended above the Arctic and Antarctic circles. However, the world at these times was also inhabited by very different plants and animals adapted to these very different climatic and environmental conditions. The warming now occurring is taking place during one of the coolest periods in earth history, when our ecosystems and human societies have been adapted to a cooler global climate. Modern climate change must be considered in the context of the current climate sensitivities of Earth's biota and the potential impacts on human society (including agricultural

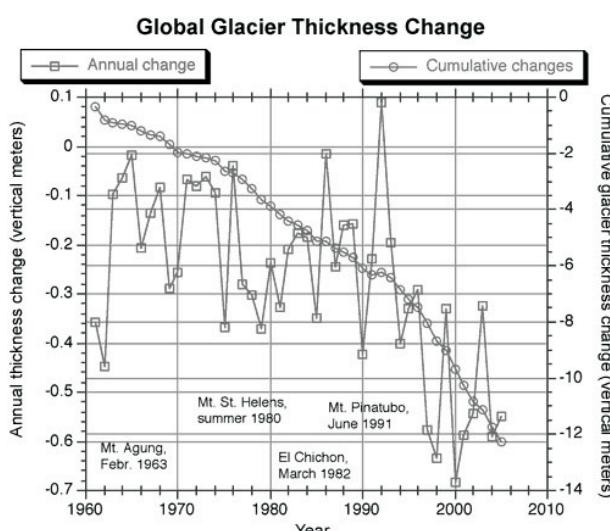


Figure 4. Average annual and cumulative change in glacier thickness for the period 1961–2005. Based on mass balance data from subpolar and mountain glaciers primarily from Europe, North America and the former Soviet Union. Graph reproduced from the National Snow and Ice Data Center. Image courtesy of Mark Dyurgerov, Institute of Arctic and Alpine Research, University of Colorado, Boulder (http://nsidc.org/sotc/glacier_balance.html).

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production, water availability, frequency of extreme events, etc.).

Also ignored, when citing climates of the geological past, is that the rate at which climate changes is critically important. When climate changes faster than terrestrial and marine organisms can respond, it can result in major disruption to the world's ecosystems and widespread species extinction. The greatest extinction in Earth history occurred at the end of the Permian Period, when up to 95% of known fossil marine species and 70% of terrestrial vertebrate species became extinct. There is now strong evidence that this extinction was at least in part the consequence of a runaway greenhouse effect initiated by the extensive release of CO₂ from the eruption of enormous lava flows in Siberia.¹³ The resulting warming was likely amplified by decreased albedo from melting polar ice, and the release of methane from thawing permafrost and the melting of methane ices from warming ocean bottom waters. The impact of this runaway greenhouse effect contributed to one of the greatest re-organizations of life on Earth. Far from providing reassurance in the face of modern climate change, the earth's climatic history provides a very sobering cautionary tale.

Claims about the extent, causes, and consequences of climate change must always be understood and evaluated within the proper context. Climate change is not about particular weather events or regional observations, but it is a summary of long-term global trends that extend over decades and centuries. In responding to the evidence of climate change, we must also think in terms of future decades and centuries. Our decisions now will have long-term consequences for our children and grandchildren.

Rejection of Scientific Consensus

Developing a scientific consensus over a set of questions is a major goal of the scientific community. The reason is that when agreement is achieved on a particular issue, it enables science to move on to new questions and thus advance our understanding. Much of the doing of science is the applying of accepted theories to new problems and new observations.

Because the scientific community is very diverse, consensus conclusions carry a lot of weight. Consensus views, while never unanimous, represent the conclusions of scientists based on the overwhelming congruence of evidence from multiple independent sources. Such consensus conclusions are not easily obtained, and they are also not easily overturned—and they should not be. Science is inherently conservative and resistant to change. Otherwise, there would be no theoretically stable foundation from which to work. Thus, when a new consensus is reached, it represents the result of the accumulation of a very large and persuasive body of evidence.

In contrast with consensus as understood by the scientific community, the public often has a very different perspective. Because of the lack of understanding of uncertainty in science, an overwhelming consensus of the scientific community may be rejected because of the critical arguments of a few individuals. When scientific conclusions are perceived as absolute statements, an entire theoretical framework may be seen as being overturned by a single contrary observation or critical study. The existence of uncertainty may also result in the public perceiving all views as equally valid since no theory is "proven." This is complicated by the tendency of the media to present "both sides" of an issue, elevating the level of perceived uncertainty and disagreement present. The result is that acceptance of a particular view is viewed simply as an appeal to authority. Theories come to be seen as philosophically or politically motivated, rather than based on evidence.

The scientific conclusion that the earth's global average temperature has been rising over the past century and that much of this increase can be attributed to human activities (primarily the burning of fossil fuels) is a well-established consensus of the scientific community. The reports of the Intergovernmental Panel on Climate Change (IPCC) are an expression of this consensus.¹⁴ The IPCC reports represent summaries of the very large and growing body of published research on climate change. The IPCC has a very detailed and thorough process established for the preparation and review of its reports.¹⁵ The first drafts of the various chapters are written by an international group of experts who summarize the peer-reviewed and internationally available

literature. For the 2007 Synthesis Report, the core writing team included forty authors representing twenty-four countries. The draft of the 2007 Synthesis Report was sent out for review to over 2,400 individual experts, in addition to the 193 member governments of the IPCC.¹⁶ These reports are extraordinary consensus statements of the climate science community. They are also inherently conservative reports because all those involved have to agree to the conclusions. As a result, this process eliminates the more extreme views. In many cases, past IPCC reports have underestimated subsequent climate change effects.

In addition to the IPCC, there are a large number of scientific, government, and corporate organizations that have made formal statements and reports on climate change. These include the American Association for the Advancement of Science (AAAS), the National Academy of Sciences (NAS), the Geological Society of America (GSA), the American Meteorological Society, the National Oceanic and Atmospheric Administration (NOAA), the US Global Change Research Program, the National Intelligence Assessment, and the US Climate Action Partnership (a coalition of major US Corporations).¹⁷

Despite the overwhelming consensus on global warming, it is still common to see reference to one or more dissenting arguments as sufficient to overturn that consensus. Joanne Nova's *Skeptics Handbook* has several statements that illustrate this low view of consensus:

No matter how qualified, how green, or how dedicated, their names and opinions prove nothing about carbon because "*argument by authority*" never can ... The IPCC is an international committee, it's not evidence. Argument by authority is not proof of anything except that a committee paid to find a particular result can produce a long document ... It only takes *one* scientist to prove a theory is wrong.¹⁸ (Author's emphasis)

It is interesting that the consensus reports of the IPCC are viewed as arguments by authority when they are simply summaries of the peer-reviewed literature. The denigration of the process of peer review is a common approach of those who reject consensus. But it is also a rejection of the entire scientific enterprise which relies on the independent testing and confirmation of interpretations to make progress in

understanding our natural world. Scientific consensus is not based on the opinion of a perceived authority, but on the repeated successful testing and confirmation of the argument itself.

Consensus is also often rejected because of a perception that the majority is driven by social, political, or religious motives. In our current media-saturated world, advocacy for causes has become increasingly separated from a concern for accuracy or faithfulness to the facts. It is therefore assumed by many that all advocacy, regardless of its source, is based on manipulation and distortion.¹⁹ Uncomfortable scientific conclusions are dismissed as attempts to advance a hidden agenda. This is seen in the charges of materialism and atheism leveled at evolutionary biologists by those who see evolution as in conflict with the Bible. Charges against the climate science community are often that they are driven by a particular social or political agenda. At the 2009 International Conference on Climate Change, a gathering of global warming skeptics, John Sununu stated:

This is a very significant event because it will give focus to the false underpinnings of the current international "rush to judgment" and the calls for implementation of drastic policies to deal with this rashly proclaimed "crisis." My message today is to make sure we recognize that no matter how effectively we deal with exposing the errors and games behind that agenda, we need to know the battle will never end, because it's not really about global warming. The global warming crisis is just the latest surrogate for an over-arching agenda of anti-growth and anti-development.²⁰

A consensus view of the scientific community is not guaranteed to be correct, but it cannot be easily dismissed. The scientific community is a very diverse one, including individuals from many different cultures and holding a wide range of religious, philosophical, political, and economic views. This diversity provides an important check on personal bias, and on political or social agendas trumping good science.

Conclusions

In the public discussion of important scientific issues, we must be attentive to the role of misconceptions about the nature of scientific explanation in determining people's views. When we fail to address

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how science works, we will only perpetuate popular misconceptions.

The scientific case for a particular conclusion must be made in terms of its power to explain patterns and trends in observations. The recognition of patterns and their interpretation through the construction of theories is the only path to a scientific understanding of climate change, or of any natural process. Furthermore, the interpretation of patterns and trends must always be done within the context of particular scales of time and space. Explanations must be scale-specific because the underlying causal processes act at particular scales. This is extremely important when evaluating claims concerning climate change.

Uncertainty is a given within science. Science never provides absolute proof but rather relative degrees of confidence. Overwhelming observational support for a particular scientific explanation is expressed by a consensus of the scientific community. This is not an appeal to authority, but rather to replicated independent observation. Anthropogenic global warming is one such consensus conclusion. Such conclusions need to be treated with great respect, and they provide the most reasonable basis upon which to base decisions and actions. To proceed otherwise is to ignore the very nature of scientific investigation itself. ★

Acknowledgments

This article is an outgrowth of presentations made at annual meetings of the American Scientific Affiliation, and at a number of other public venues over the last several years. Interactions with scientists and the public have helped to clarify the central issues. I am especially grateful for the very thorough and helpful review by Thomas P. Ackerman. Any remaining errors of fact or interpretation are mine alone.

Notes

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²Keith B. Miller, "The Similarity of Theory Testing in the Historical and 'Hard' Sciences," *Perspectives on Science and Christian Faith* 54, no. 2 (2002): 119–22.

³Joanne Nova, *The Skeptics Handbook* (2009). Copies of the booklet can be obtained online, <http://joannenova.com.au/global-warming/>.

⁴Don Aitkin, "A Cool Look at Global Warming," a presentation made to the Planning Institute of Australia at Canberra on April 2, 2008, http://onlineopinion.com.au/documents/articles/A_Cool_Look_5-4-08.pdf.

⁵Ed Morrissey, "Coldest Winter in a Decade Coming?" (September 29, 2009), <http://hotair.com/archives/2009/09/29/coldest-winter-in-a-decade-coming/>.

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⁷The confusion of weather events and climate change, and of local and global observations, is discussed in the book by Katharine Hayhoe and Andrew Farley, *A Climate for Change: Global Warming Facts for Faith-Based Decisions* (New York: Faith Words, 2009).

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⁹James M. Taylor, "Himalayan Glaciers Are Growing ... and Confounding Global Warming Alarmists" (November 1, 2006), http://www.heartland.org/policybot/results/20073/Himalayan_Glaciers_Are_Growing_and_Confounding_Global_Warming_Alarmists.html.

¹⁰The most complete data set for subpolar mountain glaciers is Mark Dyurgerov, "Glacier Mass Balance and Regime: Data of Measurements and Analysis," *INSTAAR Occasional Paper No. 55*, ed. M. Meier and R. Armstrong (Boulder, CO: Institute of Arctic and Alpine Research, University of Colorado, 2002). Distributed by National Snow and Ice Data Center, Boulder, CO, http://nsidc.org/data/docs/daac/nsidc0109_instaar.gd.html.

¹¹A new long-term study of over 7,000 glaciers of the Tibetan Plateau is the most comprehensive ever and documents glacial retreat and mass loss for glaciers over much of the Himalayas. See Tandong Yao et al., "Different Glacier Status with Atmospheric Circulations in Tibetan Plateau and Surroundings," *Nature Climate Change* 2 (September 2012): 663–7.

¹²Nova, *The Skeptics Handbook*.

¹³Peter D. Ward, *Under a Green Sky* (Washington, DC: Smithsonian Books, 2007); Michael J. Benton and Richard J. Twitchett, "How to Kill (Almost) All Life: The End-Permian Extinction Event," *TRENDS in Ecology and Evolution* 18, no. 7 (2003): 358–65; D. H. Erwin, *The Great Paleozoic Crisis: Life and Death in the Permian* (New York: Columbia University Press, 1993).

¹⁴The IPCC reports can be downloaded at http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml.

¹⁵"Procedures for the Preparation, Review, Acceptance, Adoption, Approval and Publication of IPCC Reports," Appendix A to the Principles Governing IPCC (Intergovernmental Panel on Climate Change) Work, 28 pages. Adopted at the Fifteenth Session (San Jose, 15–18 April 1999, and amended most recently at the Thirty-Fifth Session (Geneva,

6–9 June 2012). Available online at <http://www.ipcc.ch/pdf/ipcc-principles/ipcc-principles-appendix-a-final.pdf>.

¹⁶See the Appendix in IPCC, 2007: Core Writing Team, R. K. Pachauri and A. Reisinger, eds., *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Geneva, Switzerland: IPCC, 2007), 104 pp.

¹⁷A source that discusses some of these statements in a light-hearted but effective way is Greg Craven, *What's the Worst That Could Happen? A Rational Response to the Climate Change Debate* (New York: Penguin Group, 2009). For the 2010 NOAA climate report, see J. Blunden, D. S. Arndt, and M. O. Baringer, eds., "State of the Climate in 2010," *Bulletin of the American Meteorological Society* 92, no. 6 (2011): S1–S266. The Geological Society of America Position Statement on Climate Change (adopted October 2006, revised April 2010) can be found at <http://www.geosociety.org/positions/>.

¹⁸Nova, *The Skeptics Handbook* (author's emphasis).

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²⁰John H. Sununu, "The Politics of Global Warming." Remarks delivered at the 2009 International Conference on Climate Change sponsored by the Heartland Institute. http://www.heartland.org/full/24851/The_Politics_of_Global_Warming.html.

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Article

Saint Paul on Cyprus: Archaeology and the Transformation of an Apostle

Thomas W. Davis¹

The cool evening breeze provides a welcome respite from the warmth of the day. The two travelers look warily around the crowded atrium, unsure of what to do and where to be. All of the elite of the community are there, and the two latecomers are ill at ease. The official who has delivered the invitation has made it quite clear that their attendance is strongly requested. "We are but simple Jewish merchants," protests the spokesman for the pair; "we do not dine with governors." The Roman official is unperturbed. "The proconsul is an intelligent man and wishes to engage you in conversation. He enjoys having philosophical discussions after eating." After a disquieting pause he adds flatly, "He expects your attendance."

The Pauline Comfort Zone

Introduction

"The two of them, sent on their way by the Holy Spirit, went down [from Antioch] to Seleucia and sailed from there to Cyprus" (Acts 13:4),² so the Acts of the Apostles records the beginning of the most important missionary trip in

the history of the Christian church. The first missionary journey of the apostle Paul from Antioch to the island of Cyprus led to a revolutionary change in the Christian message. At Antioch, Paul of Tarsus had been within his comfort zone, a world that he knew intimately. It was a mercantile world, a Hellenistic world, and a Jewish Christian world. On Cyprus, specifically in Paphos, he was forced to enter a new reality outside his immediate experience: a political world, a patrician world, and a pagan Roman world. I believe this challenged his understanding of his calling, which changed profoundly the way he continued his missionary endeavors.

The Comfort Zone

At the beginning of the Cyprus narrative Paul is in what I describe as his "comfort zone"—the urban world of the eastern Roman Empire. Paul is an urban man.³ After his conversion on the road to Damascus, Paul spends fourteen years in Syria, Cilicia, and Arabia. After visiting Jerusalem at least once, he bases himself in Tarsus (Acts 11:25). He reflects an urban self-understanding when he tells the arresting Roman in Acts 22 that he is from "Tarsus in Cilicia," no ordinary city. Paul has a typical Hellenized self-identity, which is city based. He has the urban pride of the Hellenistic world, where one's city is more important than

Taken from "Saint Paul on Cyprus" by Thomas W. Davis in *Do Historical Matters Matter to Faith? A Critical Appraisal of Modern and Postmodern Approaches to Scripture* edited by James K. Hoffmeier and Dennis R. Magary, © 2012, pp. 405–23. Used by permission of Crossway, Wheaton, IL 60187, www.crossway.org.

one's province or kingdom. He divides the world into city, wilderness, and sea in 2 Corinthians 11:26. Throughout his career Paul travels through the wilderness and on the sea, but makes his home in cities. The churches he plants are urban associations, and he illustrates his lessons with images of urban life.

Paul is a business man, by profession a *skenopoios*, a tentmaker or, more generally, a leather worker. According to Acts 18, Paul works his trade while living in Corinth. In a speech recorded in Acts 20, Paul reminds the elders of the church in Ephesus of his business acumen: "You yourselves know that these hands of mine have supplied my own needs and the needs of my companions" (Acts 20:34). In his own writings, Paul complains that it seems that only he and his colleague Barnabas have had to work for a living (1 Cor. 9:6)! Paul is in his comfort zone in the shop and the street market.

It is par excellence, for Paul, a Jewish world, or at least a Jewish-Christian world. His Jewish *ethnos* is a core element of his identity.⁴ In 2 Corinthians he states what he calls "a little ... foolishness" (2 Cor. 11:1) in the defense of his mission, laying out his strong Jewish roots against challenges: "Are they Hebrews? So am I. Are they Israelites? So am I. Are they Abraham's descendants? So am I" (11:22). In Galatians 1:14 Paul speaks of his zeal for "the traditions of my fathers." After his conversion he remains a synagogue attendee. He is among Greek "God-fearers" in Antioch and feels called to reach out and welcome them, but it is still a Jewish world he inhabits comfortably.

Antioch

Antioch-on-the-Orontes, one of the great cities of the ancient world, becomes the "home church" for Paul for his first missionary journeys and is the heartland of the comfort zone for Paul. Located on the Orontes River near its mouth, Antioch was a nexus point for the trade routes from Mesopotamia and the north-south coastal road along the Mediterranean. One of Alexander's generals, Seleucus I, founded the city in 300 BC and named it after his father, Antiochus. Seleucus had a conscious policy of urbanization in upper Syria to create a counterweight to the ancient Mesopotamian cities; the result was the restoration of the Bronze and Iron Age patterns of urbanism.⁵

Warwick Ball suggests that the location was too strategic not to be occupied before the Macedonian foundation and that the evidence for previous settlements is obscured by the massive occupational debris beneath the modern city.⁶ The Romans gained control over the city in 64 BC when they annexed the remains of the Seleucid kingdom.

The excavations in the 1930s revealed little about Roman Antioch, owing to the eleven meters of accumulated debris and the high water table of the Orontes River.⁷ However, the basic layout of the city is known. The walls were pierced by at least four gates with five bridges across the Orontes River. The main street, crossing the city from the Aleppo Gate to the Daphne Gate, measured approximately two Roman miles in length with several strata of repaving. It was thirty-six meters wide, with colonnades on each side and probably roofing over the main carriageway. The main street was almost certainly the major market of the city, with the broad avenue lined with market stalls. *Tetrapyla* marked the major intersections, and a statue of Tiberius brooded over the main crossroads.⁸ The slopes above the Orontes River held the wealthier private quarter, placed to catch the breeze and with better views.⁹

The Roman presence in Antioch was formal and official, reflecting the strategic importance of Antioch and Syria.¹⁰ The Romans appointed governors who were politically reliable, and under the Principate, a procurator was paired with them and both resided at Antioch. Owing to the proximity of Parthia, the Roman army assigned to Syria was the largest in the east, with four legions and twenty thousand auxiliaries.¹¹ Because of the size of the army, the imperial governors had to be politically reliable, members of the aristocracy of the Principate. As part of his strategy of indirect rule, Augustus created a web of *clientalia* in the cities of the eastern empire. This helped thwart any possible tendencies to independence in the urbanized upper class.¹² These co-opted elites dominated the mercantile and social life of the city.

Beneath the "superficial veneer" of Roman rule, Antioch was a multiethnic city.¹³ Aramaic would have been the dominant language in the Syrian countryside, with the use of Greek widespread in the urban population. There was a substantial Jewish population in Antioch with its own archon.¹⁴

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Paul would have been able to blend in among his co-religionists. Seleucus I Nicator gave Jewish mercenaries the same rights as Greeks and Macedonians to settle in Antioch when it was founded. Jews lived in the southeastern quarter inside the walls of Tiberius but outside the early walls of Seleucus. Antioch's proximity to Palestine and its economic and political importance made it an attractive place of settlement for Jews. Local and ethnically related cults were important factors for maintaining personal identity in a minority situation in the ancient world, and the Roman Empire in particular witnessed this phenomenon. Synagogues fulfilled the same function for the Jewish Diaspora community. No direct archaeological evidence of a synagogue in Antioch has been recovered, but textual references document synagogues within the city and in the suburb of Daphne in the Roman period. According to one recent scholar, Antiochene Jewish life was "a rare historical example of Jews fully integrated into the life of a city while maintaining their own ancestral traditions."¹⁵

Antioch's prime mercantile location at a nexus of trade routes was an obvious advantage for Paul. The raw material for his tents would have been easily obtainable from the eastern steppe lands that have supported nomadic herders from the Neolithic period onward, and the passing trade caravans would have been a likely market for Paul's products. He probably rented a spot on one of the colonnaded markets in Antioch. Colonnaded streets were a dominant feature in eastern Roman urbanism. They functioned as market centers, replacing the typical western-style *agora*.¹⁶

From a base here, Paul could easily have traveled throughout Syria and along the Levantine coast, trading and making contacts. Antioch and Tarsus lay within the same market region being directly linked by road and by sea routes, so this was a familiar world for Paul. He had probably already established a network of clients while he was based in Tarsus, which could easily have included contacts in Antioch. The wealthy Jewish community would have provided a strong potential market for Paul, easily accessible given his shared cultural identity. The presence of a Roman army base in the city also provided another potential local market for Paul's leather goods and tents.

Seleucia was the main port for Antioch. The Roman port was artificially created north of the mouth of the Orontes because of the silting from the river; eventually this also silted up. Limited archaeological investigation in the late 1930s revealed the remains of a theater and some houses. Scattered remnants of the port installations were also identified.¹⁷

The Cyprus Connection in the Antioch Church

In Acts 11 Luke recounts the scattering of the believers after the stoning of Stephen: "Some of them, however, men from Cyprus and Cyrene, went to Antioch and began to speak to Greeks also, telling them the good news about the Lord Jesus" (Acts 11:20). Later, Luke records the names of five of the leaders of the church in Antioch, and the mention of Barnabas from Cyprus speaks to the continued influence and presence of Cypriot Christians. From the text, we must assume that the missionaries from Cyprus were Jews, like Barnabas, who is first mentioned in Acts 4. The Jerusalem church hears about this new church in Antioch (Luke shows the ability of people and news to travel easily), and shrewdly sends a Cypriot Jewish Christian, Barnabas, to find out what is happening. The relatively easy success of the missionaries in Antioch is a product of the shared cultural milieu between the Syrian city dwellers and the Cypriots. As a Cypriot, Barnabas would not be perceived as a threat by either the new converts or the missionaries and would be able more easily to gain their confidence.

Barnabas brings Paul of Tarsus to Antioch, where he will begin his publicly visible ministry. We do not know how long Paul was in Tarsus before Barnabas sought him out, but the Lukian chronology implies at least a decade. These are silent years with no mention of any ministry in either the Acts or Paul's letters, except a simple mention in Galatians 1:22, where Paul speaks of time spent in Syria and Cilicia. Of crucial importance is what is not said by either Luke or Paul: neither Luke in Acts nor Paul in his letters makes any mention of Gentile mission work that Paul might have undertaken during this period. His proselytizing appears to have been confined to the Jewish community of Damascus and possibly Arabia. If he did reach out to Gentiles in Arabia,

Cilicia, and Damascus, the results have gone unrecorded.

It is probably Barnabas who persuades the Antioch church that Cyprus should be the first “foreign” mission field for the fledgling congregation. Perhaps it is a way for the Antioch believers to partially repay the debt they owe to their spiritual midwives from Cyprus who have brought them into the new faith. It is also a safe choice, since some of the congregation probably has family ties and commercial links. Salamis, Barnabas’s home city, is only a day’s sail from the port of Antioch at Seleucia. “After all,” the church leadership may have reasoned, “if the people of Antioch responded to the gospel as presented by Cypriots, then the Cypriots should respond to a mission led by one of their own.”

Paul on Cyprus: Out of the Comfort Zone

The Cypriot Context

Cyprus is the third-largest island in the Mediterranean Sea, measuring approximately 225 kilometers east-west by 95 kilometers north-south. Located in the northeast corner of the Mediterranean, approximately 70 kilometers south of Turkey and 120 kilometers west of Syria, Cyprus is enveloped by Asia Minor and the Levantine coast. Fernand Braudel’s concept of *la longue durée*, “a history in slow motion from which permanent values can be detected” is a valuable tool for envisioning the Cyprus Paul and Barnabas encountered.¹⁸ These “permanent values” are critical to understanding the island’s cultural identity. Such permanent values include its island identity, its strategic location, and its abundant natural resources. Throughout its history, Cyprus’s island identity provided a protective shell around Cyprus’s cultural identity. As an island, Cyprus forced invasions and colonization attempts to be episodic in nature, resulting in a millennia-long process of cultural negotiation between indigenous populations and newcomers, which produced acculturation rather than annihilation. In his perceptive study of Cypriot prehistory, A. Bernard Knapp emphasizes the fluctuating degree of “openness or boundedness” on Cyprus.¹⁹

Ptolemaic Rule

Whenever dominance over the eastern Mediterranean was contested between rival powers, the control of Cyprus became a strategic necessity for the competing states. Following the death of Alexander the Great, Cyprus became a prize of war for the successor states, eventually coming under the full control of the Ptolemaic state of Egypt when the last local dynasts were suppressed. During the next two hundred years, the dynastic struggles of the Egyptian ruling house caused Cyprus to have periodic episodes of nearly independent rule under a claimant or exiled claimant to the Egyptian throne. The military ruled the island in the person of a high-ranking *stratēgos* and a mercenary garrison protected the island.²⁰

Cyprus was an economic prize in the fourth century BC as well. The 2006 discovery of a mid-fourth-century-BC shipwreck off of the south coast at Mazatos underlines the maritime importance of the island, which had been first established archaeologically by the discovery of the Kyrenia ship in the late 1960s.²¹ The Mazatos wreck appears to have carried mostly Aegean wine and may have been heading for one of the southern ports, such as Amathus or Kourion. The Kyrenia ship, which sank in the first quarter of the third century BC, likewise carried Aegean wine, but also Cypriot almonds, and was probably headed for the Syrian coast.

Nea Paphos (“Paphos” in common parlance in the first century), founded on the southwest coast at the end of the fourth century BC, became the Ptolemaic capital because of its naval advantages.²² The remains of Roman Paphos mostly obscure the Ptolemaic city, with the exception of the necropolis called the “Tombs of the Kings” (actually of the societal elites of Paphos), a late fourth-century-BC pebble mosaic depicting Scylla, an appropriate theme for a naval-oriented city, and newly discovered frescoes from a third-century-BC house, which are evidence of the rich lifestyle of the elites of the province.²³ The new city was a product of imperial power, following the pattern established by Alexander. The establishment of Paphos was a direct challenge to the primacy of Salamis as the leading Cypriot city. Geography dictated the Ptolemaic choice. Salamis harbor was silting up and lay too close to the Syrian coast, whereas Paphos could be reached from Alexandria in a direct sail that avoided

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Seleucid territory. The establishment of Nea Paphos prevented the great pan-Cypriot sanctuary of Paphian Aphrodite, located at Palaipaphos, approximately sixteen kilometers east of the newly established capital, from exercising its traditional political role in the region.²⁴

Jody Gordon has applied postcolonial theory to the Ptolemaic and Roman empires on Cyprus.²⁵ His examination of the material expression of imperial ideology emphasizes the ruling powers' attempts to seduce Cyprus into becoming a compliant province, where the negotiation of cultural identity eventually produced a politically unified province masking internal complexity. By the first century BC, Ptolemaic rule was well established and Cyprus did not have an independent voice in the civil wars of the last century of the Roman Republic.

Rome first annexed Cyprus in 58 BC, joining it to Cilicia. Cicero was the most famous early governor of the joint province. However, Julius Caesar returned Cyprus to Ptolemaic rule in the person of his mistress, Cleopatra VII. This gift was confirmed in 36 BC by Mark Anthony. Cyprus returned to Roman rule after the battle of Actium in 31 BC.

Current excavations on Yeronisos Island, a small islet off the west coast of Cyprus, illuminate the last days of Ptolemaic rule under Cleopatra. On Yeronisos, Joan Breton Connelly has excavated the fragmentary remains of a late Hellenistic-style temple.²⁶ She hypothesizes that the temple was associated with boys' rites of passage, in light of the recovery of small limestone amulets normally depicted on "temple boy" sculptures from the Hellenistic world. She persuasively argues that the temple was dedicated to Cleopatra, the New Isis, and her son by Julius Caesar, Caesarion, the New Horus, marking his passage to adulthood. This would be in keeping with the Ptolemaic tradition of a royal cult, first established on Cyprus when Arsinoe Philadelphus, the wife of Ptolemy II, was deified on her death.

Roman Rule

Augustus separated Cyprus from Egypt and made it a senatorial province, governed by a proconsul. By the beginning of the first century AD, Cyprus was already becoming a political backwater in the Roman Empire. The ancient sources are largely silent about

the island during the Roman period. In Mitford's words, "In 22 BC Cyprus entered upon more than three centuries of tranquil obscurity."²⁷ Inscriptions and coins together record only forty-eight proconsuls from 22 BC to AD 293, less than a sixth of the total. The proconsul served for only a one-year term; Mitford points out that this short period of office prevented corruption. In consequence, Cyprus probably was not seen as an attractive posting for a young Roman aristocrat who needed to line his pockets to advance his political career; we know of only six governors who went on to become consuls. Proconsuls had quaestors to assist them in public finance; the proconsul would normally have an advisory council and could summon locals for help. Cyprus was divided into four administrative districts.

Augustan coinage for Cyprus reflects a conscious attempt to integrate Cyprus into the empire. One Cypriot Roman coin uses a portrait bust of Augustus that echoes strongly back to the coinage of Julius Caesar.²⁸ This may have been a deliberate attempt to highlight Octavian's Caesarian heritage, designed to appeal to supporters of the defeated Ptolemaic monarchy. In the political hagiography of the Ptolemaic kingdom, Caesar was a "good Roman" who supported their queen and fathered their last king.

Despite political obscurity, Cyprus retained economic importance. Dimitrios Michaelides has emphasized the importance of Cyprus's economic role and the outsized contribution the island made to the Roman economy.²⁹ His survey of the economic role of Cyprus highlights the amount of perishable items Cyprus may have exported, evidence that has not survived in the archaeological record. The island continued to be a major source of copper; Augustus supplied King Herod with 150 talents in annual revenues from half of the mines and allowed the king to directly manage the other half.³⁰ There is no evidence of any imperial estates on Cyprus, but centuriation (laying out of agricultural field strips by imperial surveyors) near Salamis might indicate the reallocation of land confiscated from Ptolemaic elites.³¹

Urban life flourished in the Roman period on Cyprus. There is a great deal of archaeological and inscriptional evidence for extensive building in the first century AD in the Cypriot urban centers of Paphos, Salamis, Kourion, Amathus, and Soloi.

New temples, baths and aqueducts, public spaces, and markets were constructed. It is fair to say that Cyprus circa AD 50 was an urban world. Following the dictates of its island identity, the large urban centers of Cyprus lay on the coast. This coastal orientation was strengthened on Cyprus by the security situation under the *Pax Romana*, and would continue until the seventh century AD.

The Cypriot cities in the Roman period lacked the usual sense of strong local identity that most cities in the eastern empire evidenced. Cyprus did not have many urban dedications that exalted the city; for the most part, the inscriptions were dedicated to the imperial family on behalf of an individual, or the community, the *koinon kyprion*. A sign of the diminished role of urban identity is that in the reign of Claudius, the *koinon kyprion* was made responsible for minting the coins of Cyprus rather than individual cities.³²

Religiously, Cyprus maintained its public attachment to the traditional male and female deities of Cyprus, with roots far back into prehistory. The Romans knew them as Aphrodite, Zeus, and Apollo. It is no surprise that the earliest segment of the Roman road system to be completed was the segment joining the temple of Apollo Hylates at Kourion with the temple of Aphrodite at Palaipaphos.³³ The Aphrodite sanctuary, founded in the Late Bronze Age, remained a major pilgrimage shrine under both Ptolemaic and Roman rule. The Romans continued the Ptolemaic policy of a ruler cult. As a Julian, Augustus was able to follow his adopted father, Julius Caesar, and claim descent from Venus, that is, Aphrodite. The great temple of Palaipaphos, with its claim to be the birthplace of the goddess, was an obvious candidate to become the “national” shrine of Roman Cyprus.

Salamis

The site of Salamis has been excavated since the late nineteenth century, mainly by a major French mission, the British colonial authorities, and Dr. Vassos Karageorghis on behalf of the Department of Antiquities of the Republic of Cyprus. The *coup d'état* against Cypriot President Makarios in July 1974 led to the invasion and occupation of northern Cyprus, including the site of Salamis, by the Turkish army.

Since that date, no internationally condoned archaeological excavations have been undertaken in the areas outside the direct control of the Republic of Cyprus. Turkish Republic archaeologists and Turkish Cypriot scholars have undertaken some excavation and survey work in the north of Cyprus, but these are not published internationally and have been condemned by UNESCO and the international community.

Salamis was excavated in the classical tradition of large-scale exposures with a focus on public space, the setting for the political and social elites of the ancient world. The primary aims of such excavations were chronology building to elucidate political history, and the recovery of works of art and ancient inscriptions. This reflected the desires of the Western (European and American) intelligentsia and the membership of the funding societies, including societal elites linked to the museum community.

Salamis was founded after the abandonment of the Bronze Age entrepôt of Enkomi around 1050 BC.³⁴ A powerful city-state in the Iron Age, Salamis was heavily involved in the Persian wars for control of the island. Blessed with a rich agricultural hinterland and a prime location along the shore facing the markets of Syria, Salamis was the dominant city politically, culturally, and economically before the time of Alexander.

Salamis was still in the comfort zone for Paul. First-century Salamis contained all the urban amenities characteristic of a successful and prosperous eastern Roman city. It had grown organically, rather than as a product of imperial fiat. Travelers entering the city from the harbor would pass through a major bath-gymnasium complex graced with fine statuary and elegant frescoes. Paul and Barnabas would then have encountered a magnificent theater with a seating capacity of fifteen thousand. Other excavated urban public spaces include the Hellenistic agora, still functioning in the Roman period, and the famous temple of Zeus Olympios, also founded in the Hellenistic period. The line of the classical/Hellenistic city wall, probably still functional in the Roman period, has been identified. Recent excavations by the University of Ankara have identified a major urban thoroughfare, lined with shops, reflecting the eastern Roman commercial pattern.³⁵

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A population estimate based on the aqueduct capacity suggests a first-century population of around 120,000.³⁶ All of this would have been familiar and comfortable territory for Paul.

None of the excavation teams have yet focused on the domestic space of Salamis. We have no sense of the cityscape, how its visible amenities were linked, or what the arrangement of the neighborhoods was. Understandably, we lack any evidence of a synagogue, although Salamis had a very large Jewish population, who were encouraged to settle there under the Ptolemies. Acts 13:5 emphasizes the large Jewish population in the city when it reports that Paul and Barnabas proclaimed their message in the “Jewish synagogues” (plural). The late fourth-century basilica of St. Epiphanius, was built within a domestic quarter after a major earthquake in AD 342 severely damaged the city. In light of the placement of early Byzantine churches in urban neighborhoods in the Levantine mainland, one would normally argue that the neighborhood of the basilica of St. Epiphanius was likely to be Jewish and may have had a synagogue as a near neighbor.³⁷ However, the total destruction of the Cypriot Jewish community in the Diaspora revolt of AD 117 eliminates this line of research for understanding the Jewish neighborhoods of Salamis. Barnabas was a native of Salamis, and his purported tomb outside the city is now a major pilgrimage site on the island. Paul and Barnabas were almost certainly hosted by his family, but we cannot yet provide the proper domestic backdrop for this visit.

Paphos

The book of Acts records that Paul and Barnabas traveled “through the whole island” (Acts 13:6) until they arrived in Paphos. The Roman road system on Cyprus was not completed until sometime in the early fourth century AD, but some sections were already in place by the Pauline visit.³⁸ The first segment completed under Augustus linked the temple of Apollo at Kourion and the temple of Aphrodite at Palaipaphos.³⁹ This had a strategic value, linking the political capital with the prime religious sanctuary of the island. A Roman governor would want quick access to the temple leadership, and more importantly, to the treasury. Undoubtedly the Roman roads followed Ptolemaic and older tracks where

available. David Gill points out that Luke’s phraseology implies a land journey without using the more efficient coastal shipping.⁴⁰ We do not know how long the passage across Cyprus took Paul and Barnabas. A direct journey from Salamis to Paphos, stopping only at night, would have taken about seven days. Since the missionaries had already spent some time in Salamis speaking in a number of synagogues, it is more likely that they did not feel time constraints. If it was a more leisurely passage, then a two-wheel vehicle was the likeliest form of transport for two commercial travelers such as Paul and Barnabas.⁴¹ This cart could carry their trade goods, that is, tents. We know Paul worked during his future mission journeys; there was no reason why Barnabas and Paul could not have teamed up here to do business as well since it appears they had the time.

They almost certainly passed along the southern coastal road as this was a major track linking the coastal cities and the best way by foot to Paphos. The fourth/fifth-century text entitled *Acts of Barnabas* records a journey of Mark and Barnabas that supposedly retraced the original route of Paul and Barnabas. In this text they pass along the coastal road, seeing both the temple of Apollo at Kourion and the temple of Aphrodite at Palaipaphos. Although the coastal road was present in the first century AD, the itinerary of the *Acts of Barnabas* reflects the mature Roman road system of Late Antiquity. This text is more likely a product of the campaign of the institutionalized Cypriot Church to gain autocephalous status.⁴²

The Cypriot journey of the apostle ended at Paphos, the capital of the Roman province. The city had been severely damaged in an earthquake, leading Augustus to intervene and help repair the city. In gratitude, the city was renamed Sebaste. Later Claudius would name the city Sebaste Claudia Flavia.⁴³

The site of Paphos has been investigated since the 1960s by the Cyprus Department of Antiquities and a number of foreign missions. The discovery of the first urban house with intact mosaics was the result of a chance discovery during construction activity in 1962.⁴⁴ Since then, it has become clear that magnificent floor mosaics were common among the elite houses of Paphos.

The Roman city Paul entered is hard to envision and its remains are almost completely obscured by the monumental public buildings and magnificent urban villas of the second and third centuries AD. The city was walled and was laid out on a grid system with well-defined commercial and residential quarters. It was graced with an excellent harbor, which gave a strong impetus to trade.⁴⁵ The main civic theater, recently uncovered near the Kourion gate, seated 8,500. The magnificent House of Theseus is considered to be the residence of the Roman governor.⁴⁶ It is the largest residence known from Roman Cyprus, measuring at 120 × 80 meters, with more than a hundred rooms. It is thought to date to the third century AD and continues to be occupied after a series of earthquakes in the fourth century severely damaged the city, leading to the provincial government being moved to Salamis. Fragmentary evidence of a previous structure on the site may be all that remains of the governor's residence at the time of the Pauline visit. It is certainly possible that Sergius Paulus occupied another residence, which has not been located.

The Encounter: Out of the Comfort Zone

The main focus of the account in Acts of the Cyprus mission is the encounter in Paphos between Paul and the Roman governor, Sergius Paulus.⁴⁷ Luke sees this as a seminal event, changing Paul's name and, in essence, his ministry. Although the change of name has been subjected to extensive speculation in biblical scholarship,⁴⁸ the impact on the ministry of Paul has been almost ignored. There seemed to be no rationale for a change in Paul's thinking at this time. The image of a province unified by Augustan *Romanitas*, such as in Mitford's magisterial survey of Roman Cyprus, has provided the cultural backdrop for scholarly analysis of the Pauline encounter. This homogenization of Roman Cyprus has obscured any suggestion of a new environment or new pressures that might have produced a Cypriot impact on Pauline theology.

A Cultural Divide

An examination of recent scholarship on Roman Cyprus suggests that the province was not as unified in the first century as previously thought. The elite

of Paphos appear to have embraced elements of a separate cultural identity from the rest of Cyprus. New studies indicate an east/west economic divide in Roman Cyprus between Paphos and the eastern two-thirds of the island. Anthi Kalidelis's doctoral study of Roman trade amphorae found on Cyprus indicates the complex interchange network Cyprus took part in.⁴⁹ Kalidelis's analysis shows that Amathus and Salamis traded heavily with Antioch, Cilicia, and the Levant, while Paphos looked strongly west with a high percentage of imports from Italy and Rome itself; this is particularly strong in the first century. The evidence presented by John Lund in his studies of Roman fine ware suggests a similar division.⁵⁰ The Paphos region was the production center for Cypriot Sigillata fine ware, while Eastern Sigillata ware produced in Syria dominate the fine ware sub-assemblages of Salamis and Amathus.

Roman coinage under the Julio-Claudians also hints at an east/west social/cultural divide that the first-century Romans were aware of. Under Augustus, the primary mint appears to have been in the provincial capital of Nea Paphos, and the coins seem to have been widely circulated. Gordon points out that the iconography and legends were presumably selected by Roman officials and mint officials and thus can be read to illustrate their goals for and attitude about Cyprus and Cypriots.⁵¹ On this evidence, Rome was aware of a provincial divide between east and west. A series of coins produced under Augustus has two distinct reverse images: the temple of Aphrodite at Palaipaphos and the temple of Zeus at Salamis, built under imperial patronage of the Ptolemies.

The concurrent issuing of a "Salamis" coin may have been an attempt to acknowledge or recognize a religious divide in the province. The Palaipaphos temple image was meant to address the local elite in the Paphos area, while the statue of Zeus reverse was intended to appease Salaminians, thus placating both segments of the island.⁵²

Paphos appears to be a particularly "Roman" district. Elsewhere in the eastern empire, depictions of temples housing the imperial cult are common on contemporary coin issues. On the basis of this, and the obvious "family" links of the Julians to Aphrodite, many scholars have suggested that the imperial

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ritual may have been somehow blended with the island's primary cult to Aphrodite.⁵³

The east/west dichotomy is also hinted at by Parks in her discussion of the second use of the Aphrodite temple/Zeus Salaminos on coin issues by Drusus Minor.⁵⁴ Drusus, Tiberius's son, actually combined both images on one coin, further encouraging a unified province. Parks states that both images may have been used "to keep the people of each city happy." Barnabas seems to show evidence of the Cypriot cultural divide in his life as Luke depicts it in Acts. Barnabas, like Salamis itself, has an eastern orientation. He is at home in Jerusalem, Antioch, and eastern Cyprus, but when the story shifts to Paphos, Paul becomes the spokesman and leader. Luke portrays Paul as more open to the cultural challenge of the pagan Roman world than Barnabas, who appears out of his depth. This could also be evidence of a subtle anti-Roman bias in Barnabas, perhaps because he was from Salamis, the quintessential Hellenistic city of Cyprus. Fergus Millar notes the value of the New Testament writings for their insight into the negotiation of identity between subject and ruler in the Roman Empire, and Paul and Barnabas may epitomize this negotiation in a Cypriot context.⁵⁵

The Encounter

Paul and Barnabas are invited by the governor to discuss their beliefs in Acts 13:7. This is the first record of a conversation between Paul and a high Roman official, certainly not a comfortable moment at this point in the apostle's life. Although dating after the Pauline visit, the House of Theseus does provide us with an idea of how the Roman governors wanted to display themselves and how a visitor would have been forcibly reminded of Roman power and authority. The visitors' atrium was provided with benches and was dominated by a statue of a nude Venus armed with a bow. It has been suggested that this statue may also represent Roma, combining the main goddess of Cyprus with the titular goddess of the empire.⁵⁶

It is most likely that Paul and Barnabas are invited to be part of the after-dinner "entertainment" at a banquet given by the governor. Philosophical readings and discussions would be a normal part of the evening at the home of an "intelligent man"—one

who was educated, spoke Greek, was interested in philosophical questions, and therefore was open to a new faith. The inclusion of the Jewish magician Bar-Jesus makes it almost a certainty that this was more of a social occasion than an official meeting held during office hours. The rival philosophers would be pitted against one another for the enjoyment of the dinner guests and, in the governor's case, out of an honest interest in the subject. If this is a correct interpretation of the setting for the conversation, then this is also the first time Paul has been invited to a pagan Gentile's house for dinner; another experience outside of his "comfort zone."

A recent study of Roman Cypriot magic texts from the site of Amathus makes clear that Luke's account of the contest between Bar-Jesus and Paul accurately reflects a Cypriot milieu.⁵⁷ Cypriot magic was often employed to prevent someone from speaking, and blindness could be used as a preventative measure in these cases; in the Acts account, Bar-Jesus is trying to prevent Paul from speaking to the governor about the faith; so in typical Lukian irony, the magician is struck down by the very weapon he was probably trying to use against Paul. After some discussion, Sergius Paulus "believes," but he is not baptized (Acts 13:12). It is likely that he has had a personal conversion, making Jesus his personal deity, while still maintaining the religious aspects of his public role as governor.

The Impact on Paul

When Paul entered Paphos he crossed an economic, social, and political boundary that divided the province into an eastern-oriented zone and a western-oriented zone. It is now reasonable to propose that in Paphos, Paul left behind the economic, social, and religious comfort zone in which he had spent his entire Christian ministry. Therefore, when Paul met the governor, it is certainly possible that he was for the first time forced to confront new possibilities in his Christian mission. The positive results of his encounter with the governor, in contrast to the apparent failure of the synagogue mission within the Pauline comfort zone in Salamis, may provide the catalyst for a fundamental change in the Pauline ministry: Paul now embraces the truly pagan world as his mission field. In Pisidian Antioch he first goes to the synagogue, where he preaches his "classic" outreach

sermon to the Diaspora Jews. Luke records that when his sermon is challenged by some of the Jews, Paul responds, "We now turn to the Gentiles" (Acts 13:46).

Paul's retelling of his conversion in the Acts accounts (Acts 22 and 26) makes his call to Gentile ministry to be contemporaneous with his conversion.⁵⁸ This is the central message of the vision Paul had in the temple during his first visit to Jerusalem. However, he may have been resisting this call until he saw the work of the Holy Spirit in Paphos. The first letter Paul writes to the churches he may have visited on this trip, Galatians, shows his embrace of the call and is a defense of his Gentile ministry. Paul in his own letters defines his own ministry as "Gentile" in aim from the very beginning. It is possible that Paul is indulging in a little hindsight here, reading his growing understanding of his true calling back into his original conversion and the beginnings of his ministry.

Luke consistently has Paul first reaching out to Jews, and only after he has been rejected does he reach out to Gentiles. In Luke's report of Paul's defense before Agrippa, he quotes the apostle: "First to those in Damascus, then to those in Jerusalem and in all Judea and to the Gentiles also" (Acts 26:20). Notice the separation of the dwellers in Damascus and Jerusalem from the Gentiles. The implication is that he has reached out to his fellow Jews as well as to Gentiles.

This cultural shock of Paphos also eliminates much of the perceived "tension" between Luke's record of Paul's practice of first seeking out a Jewish audience and Paul's self-proclaimed call to the Gentiles. It also may be a semantic difference between Luke and Paul. Luke may think of real "Gentile" ministry as outreach to untouched pagans. It is possible, however, that Paul's initial "Gentile" outreach was confined to the already acclimatized Gentiles (in religious terms), who have already been attracted to Judaism—the so-called "God-fearers" who would have been most easily encountered in the synagogue.⁵⁹ Paul may also be referring to Diaspora Jews who have shed their religious identity and have been Hellenized. A recent sociological study of the early church concludes that Diaspora Jews were the overwhelming majority of converts in the first centuries of the faith.⁶⁰ In this scenario,

Luke is accurate in that Paul first targeted the synagogue, and Paul is correct in that he specifically targeted the "Gentile" Hellenized secular Jews and the Greek converts to Judaism.

Lukan Accuracy

Current archaeological evidence demonstrates that Luke's understanding of mid-first-century Cyprus is accurate and nuanced. The cultural shock Paul experienced in Paphos provides the unexplained justification for the change in Paul's theology. The east/west cultural divide that Paul encountered in Roman Cyprus was strongest in the first half of the first century, exactly when Luke places Paul on Cyprus. Archaeological evidence for the east/west cultural divide after the mid-first century lessens, particularly in the numismatic evidence. Following the reign of Claudius, Cypriot coinage minted on the island is labeled as the product of the *koinon Kyprian* and indicates that the elites of the Cypriot cities are presenting a unified message, acting in concert with Rome.

The vibrant mid-first-century Jewish community with strong ties to Judea depicted by Luke also is supported by the evidence of Cypriot coinage. Judean coins on Cyprus are "quite common" during the Julio-Claudian period, but almost disappear at the time of Vespasian.⁶¹ By the early second century Judean imports completely disappear from the archaeological record and are replaced by Roman imperial coins minted in the west.⁶² This is stark evidence of the complete destruction of the local Jewish community in the Diaspora revolt of AD 117. Although John Dominic Crossan and Jonathan Reed, in a recent study of Paul, recognize that Luke may include "correct details, accurate places and even travel sequences," they conclude negatively: "Luke's Acts were written in the 80s or 90s, several decades after Paul's time, and Luke gives him an overall interpretation from within his geographical situation, historical understanding and theological vision."⁶³ The picture of mid-first-century Cyprus derived from the archaeological data challenges this confident assertion and strongly improves the case for the book of Acts to be an accurate reflection of a mid-first-century milieu. When measured by the current state of archaeological understanding, Luke's account of Paul's Cyprus visit reflects a

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cultural geography that can be found only during the mid-first century.

This new understanding of mid-first-century Cyprus also provides a psychologically clear justification for Paul's radical theological vision of the Gentile ministry. When Paul returns to Antioch from his Cypriot mission, he has been transformed, the gospel message has been transformed, and as a result, the "followers of this Way" (Acts 22:4) will be transformed. "On arriving there, they gathered the church together and reported all that God had done through them and how he opened the door of faith to the Gentiles" (Acts 14:27). The invitation to Jews to accept the Messiah of God has become an open door to the entire pagan world, and a Jewish messianic sect will become the Christian church. The crucible for all of these changes is Cyprus. ★

Notes

¹Thomas W. Davis conducted extensive research on the archaeology of Cyprus during his tenure as director of the Cyprus American Archaeological Research Institute. He took up his position on the faculty of Southwestern Baptist Theological Seminary for the fall term of 2011. He is director of excavations at Kourion.

²Scripture quotations in this chapter are from the New International Version, 1984 edition.

³Wayne Meeks, *The First Urban Christians: The Social World of the Apostle Paul* (New Haven, CT: Yale University Press, 1983).

⁴F. F. Bruce, *Paul: Apostle of the Heart Set Free* (Grand Rapids, MI: Eerdmans, 1977). Bruce remains my guide to all things Pauline.

⁵Henri Seyrig, "Séleucus I et la fondation de la monarchie syrienne," *Syria* 47 (1970): 290–311.

⁶Warwick Ball, *Rome in the East: The Transformation of an Empire* (London: Routledge, 2001), 157.

⁷Richard Stillwell, ed., *Antioch-on-the-Orontes III: The Excavations of 1937–1939* (Princeton: Princeton University Press, 1941), 7. The Antioch excavations were a classic example of colonialist treatment of archaeological heritage. The international consortium of museum and universities sponsoring the excavation removed half of the recovered mosaics (more than three hundred) to their respective museums.

⁸Ball, *Rome in the East*, 155.

⁹Christine Kondoleon, ed., *Antioch: The Lost Ancient City* (Princeton: Princeton University Press, 2000).

¹⁰Glanville Downey, *A History of Antioch in Syria from Seleucus to the Arab Conquest* (Princeton: Princeton University Press, 1961).

¹¹Alan Bowman, Edward Champlin, and Andrew Lintott, *The Augustan Empire*, 2nd ed., The Cambridge Ancient

History 10 (Cambridge: Cambridge University Press, 1996), 714.

¹²Meeks, *First Urban Christians*, 12.

¹³Ball, *Rome in the East*, 157.

¹⁴Wayne Meeks and Robert Wilken, *Jews and Christians in Antioch in the First Four Centuries of the Common Era* (Ann Arbor, MI: Society of Biblical Literature, 1978), 1.

¹⁵Bernadette Brooten, "The Jews of Ancient Antioch," in Kondoleon, *Antioch*, 29–38.

¹⁶Ball, *Rome in the East*, 262.

¹⁷Stillwell, *Antioch-on-the-Orontes III*.

¹⁸Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II*, vol. 1 (New York: Harper & Row, 1972), 23.

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A Physics Challenge

Science is constantly moving. **Robert Mann**, professor of physics at the University of Waterloo and former president of both the Canadian Association of Physicists and the Canadian Scientific and Christian Affiliation, has written an intriguing description of the latest developments in physics along with insights and challenges that they may raise for Christian faith. It can be read at www.asa3.org or www.CSCA.ca.

This article is intended as an invitation. Readers are encouraged to take up one of the insights or challenges, or maybe a related one that was not mentioned, and draft an article that contributes to the conversation. These can be sent to Mann at robertmann@sympatico.ca. He will send the best essays on to peer review and then from those we will select some for publication in a physics theme issue of *Perspectives on Science and Christian Faith*. For full consideration for inclusion in the theme issue, electronic files should be received by Mann before December 31, 2012.



Gary Patterson

Article

Theology and Thermodynamics: In Praise of Entropy

Gary Patterson

Thermodynamics is an exact macroscopic theory with no known exceptions. It has a long history of development that includes many famous Christian scientists. Recent developments in theology have occasionally invoked thermodynamic quantities or concepts in ways that are not consistent with either good science or theology. The present article presents a brief introduction to both classical and statistical thermodynamics, with an emphasis on the role of the entropy in the description of our physical world.

Several attempts to imprecise entropy are examined and refuted. Thermodynamics is then discussed as a way of thinking that provides a sound basis for appreciating the importance of the God-given entropy for our life and thoughts.

We live in a rich and complicated universe. The physical universe is well described by an exact macroscopic physical theory known as thermodynamics.¹ The study of God and his relationship to the entire universe, including the physical, biological, personal, social, and spiritual worlds is the subject of theology.²

This article will describe the nature of thermodynamics at a level that allows reflection on its significance for theology. While an attempt will be made to minimize the use of abstract mathematics, it should be understood that the “language of science” is mathematics.

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Just as considerable effort needs to be expended to learn and comprehend the abstract language of theology, there is no easy street to thermodynamics. Failure to acknowledge this fact has often led to severe misunderstandings of the highly technical aspects of thermodynamics and unfortunate conflations of precise scientific concepts with vague colloquial notions. This type of error has especially appeared in connection with the thermodynamic quantity known as *entropy*.

The basic stance of this article is that theologians should understand thermodynamics well enough to avoid obvious errors, and perhaps even well enough to benefit from many useful paradigms developed during the history of the subject. Since many of the “Fathers of Thermodynamics” were devout Christians,³ it is fitting for their followers to continue to bring the benefits of thermodynamic thinking to the process of rational religious reflection on the purpose and meaning of humanity.

Outstanding treatments of thermodynamic issues and their relationships to religion have previously appeared. Two good examples are "The Uses and Abuses of Thermodynamics in Religion" by Erwin N. Hiebert⁴ and "Pierre Duhem, Entropy, and Christian Faith" by Helge Kragh.⁵ In the nineteenth century, many theologians worried about the consequences of the proposed "heat death" of the universe. The French physicist and historian, Duhem, was an expert in thermodynamics who practiced in the late nineteenth and early twentieth century. He was a contrarian in many of his thoughts, but he was a deep scientific thinker as well as a Roman Catholic believer. This article focuses on some current theological issues, especially the misuse of the concept of entropy, and the current understanding of classical, statistical, and nonequilibrium thermodynamics.

Energy

One of the landmarks of modern science was the development of the concept of energy.⁶ The universe is conceptualized in terms of a set of objects known as particles. Typical particles include entities such as electrons, light (photons), and protons, but there are a very large number of different kinds of particles currently included in the conceptual world of physics.⁷ Although the understanding of physical matter and electromagnetic energy is greatly helped by adopting a microscopic perspective, the science of thermodynamics is concerned with large quantities of matter and energy as it is normally observed with macroscopic instruments.⁸ The restriction to systems of many particles is actually essential for understanding some of the most important principles of thermodynamics. Eventually a very formal version of thermodynamics was developed that emphasized its independence from the microscopic details of the physical system. This positivistic system was exemplified by the work of Mach, Ostwald, and Duhem.

A precise picture of the state of a physical system requires the introduction of an important physical concept: temperature. The thermodynamic temperature, T , is a measure of how the energy of the system is distributed among its microscopic states. Thermodynamic analysis consists of a set of relationships between measurable macroscopic properties.⁹ The thermodynamic energy, U , is the *average* value of the

system energy. If the temperature is fixed by contact with a heat bath at temperature T , the instantaneous energy fluctuates in a stationary way around the value of U . The existence of fluctuations is the key to understanding the actual properties of equilibrium physical systems.¹⁰

The thermodynamic energy of a single component system can be expressed as a mathematical function of T ; volume, V ; and the mass of the system, m . Changes in U can then be expressed in terms of changes in T , V , and m . If the system is isolated (no exchanges of energy or mass with the outside world) and fixed in volume, the energy of the system must remain constant, since no energy may enter or leave the system. One way to change the energy of the system is to change the temperature by placing the system in thermal contact with a heat bath at a different temperature. The amount of heat, Q , which flows into or out of the system, is then equal to the change in thermodynamic energy, ΔU .

Another way to change the thermodynamic energy is to change the volume of the system under conditions where no heat can flow into or out of the system. The energy change under these conditions is called work, W . In a more general circumstance, the total energy change can be expressed as: $\Delta U = Q + W$. This expression is often called the *First Law of Thermodynamics*.¹¹ However, the full expression of the First Law includes every way that the thermodynamic energy can change, and it concludes that if no matter can enter or leave the system, no heat or light can enter or leave the system, and no work is done on or by the system, then the value of U must remain the same. Isolated physical systems are characterized by conservation of energy. The absolute principle of energy conservation is associated with James Prescott Joule.¹²

Thermodynamics is inherently relational. This way of thinking has also been introduced into discussions of theology.¹³ Rather than focusing mostly on the properties of isolated concepts, this new form of Christian theology emphasizes the relationships between God, humans, and their physical and spiritual worlds. Keeping track of the relationships between entities in the human and spiritual world helps to clarify the changes that are seen. While some scientists insist that changes in the spiritual world can

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have no influence in the physical world, it is not thermodynamics that drives them to this conclusion. Thermodynamics warns us to be constantly on the lookout for correlated changes and the mechanisms that are associated with these changes. Careful observation is just as valuable in theology as it is in thermodynamics.

Entropy

If the temperature were at absolute zero, $T=0\text{ K}$, where K is the absolute unit of temperature named after Lord Kelvin, then an equilibrium system would adopt a state in which the microscopic particles were in the lowest possible energy level. The notion that in this lowest energy state, the kinetic energy is still above zero, is one of the great insights of modern statistical thermodynamics.¹⁴ When the temperature is positive, the system can sample the available microscopic energy states, and an equilibrium state includes a distribution of microscopic states. The system is constantly fluctuating in instantaneous energy, either by interaction with an external heat bath or by local fluctuations in temperature within the system.

The dynamic nature of equilibrium requires an additional concept in order to describe the thermodynamic state of the system. It is found that the meaning of temperature is best expressed in terms of the partial derivative of the energy with respect to a variable called entropy, S, at constant volume: $T = (\partial U / \partial S)_v$. At very low temperatures, the energy of the system changes very slowly, even though the entropy changes enormously. What is this new variable that is so important to an understanding of thermodynamic equilibrium and temperature?

The *Third Law of Thermodynamics* states that for a perfect monatomic crystal, the entropy, S, approaches 0 as T approaches 0.¹⁵ This state of zero S corresponds to a system in its unique ground state energy level. In order for the temperature to rise, there must be slightly higher energy states of the system that can be populated by some mechanism, such as the absorption of heat, light, or magnetic energy. For the same change in U, the temperature of the new state of the system will be determined by how many microscopic states of the system are

accessible under the conditions of increased internal energy, U. A system with very many microscopic states is much more “stable” physically than one with only a few states. The system at absolute zero is often described as fully ordered. A system at a higher value of U will have a value of S that is determined by the extent to which the distribution of microscopic energy states achieves a maximal breadth, consistent with the total energy and equilibrium. This state is often described as “disordered,” but from a thermodynamic perspective states of high S are more stable.

The ordinary English usage of the word “disorder” has negative moral connotations, but the thermodynamic usage has none of these negative tones. When theologians use “scientific” terms, but imply their colloquial meanings, great mischief results. An example of this kind of confusion is found in the book *The Jesus I Never Knew* by Philip Yancey: “Death, decay, entropy, and destruction are the true suspensions of God’s laws.”¹⁶ There is nothing spiritually positive about absolute zero, even though this may imply a perfectly ordered state. The world God actually created is characterized by temperatures higher than zero, even in the deep regions of space!

Changes in the entropy can also be related to changes in other thermodynamic variables. If the system is closed to mass flow, and the volume is fixed, the entropy change for a heat flow Q at temperature T is $\Delta S = Q/T$. One of the insights that flow from this relationship is that under high temperature conditions, the entropy changes only slightly for the same heat flow. The entropy will also increase as the volume increases. If the internal energy U is held constant, a system will only change spontaneously if the entropy increases. This is an insight known as the *Second Law of Thermodynamics*.¹⁷ Like the First Law, there are no known violations. A system of maximal entropy is already at equilibrium. The equilibrium state is the most probable state for a system and hence has the highest entropy, consistent with the temperature, volume, and mass. While fluctuations do occur, they are part of a stationary pattern of changes and no change in the thermodynamic entropy occurs. The thermodynamic entropy is determined by the *long time average* of the system, not an instantaneous state of the system.

When the value of S does change, the details of the distribution of fluctuations also change. This is the key insight that leads to the physical phenomenon of “*irreversibility*.” The two states of the system involve different fluctuations around a different average, not just a change in S. Recognition of this fact eliminates many supposed “paradoxes” with regard to the entropy.

The importance of the Second Law was elegantly expressed by Sir Arthur Eddington in *The Nature of the Physical World*:

The law that entropy always increases holds, I think, the supreme position among the laws of Nature. If someone points out to you that your pet theory of the universe is in disagreement with Maxwell’s equations—then so much the worse for Maxwell’s equations. If it is found to be contradicted by observation—well, these experiments do bungle things sometimes. But if your theory is found to be against the second law of thermodynamics I can give you no hope; there is nothing for it but to collapse in deepest humiliation.¹⁸

What does all this discussion have to do with theology? Entropy is one of the most important concepts in the understanding of the normal behavior of our universe. Left to themselves, physical systems at constant energy change in such a way as to achieve the most probable dynamic state of the system, and hence the maximum entropy. Suggestions by theologians that entropy is “evil” only serve to marginalize them in the public square.

The most prominent proponent of the view that entropy is evil was Henry M. Morris of the Institute for Creation Research. A typical expression of his views is contained in the chapter entitled “Thermodynamics and Biblical Theology” in the Creation Research Society publication *Thermodynamics and the Development of Order*.¹⁹ Morris attempts to paint a picture of the earth “in the beginning” that does not have entropy. This is a serious misunderstanding of the physical world. If the system is not at absolute zero (and is not a monatomic, single crystal), it must have a positive entropy. The textual assertion in Genesis 1 that the earth was “good” is not equivalent to a claim that the entropy is zero. Morris is also concerned with the consequences of the Fall. He proposed that after the Fall, entropy increased and sin proliferated. I have been in the room at the

Institute for Creation Research devoted to imprecating entropy. It demonstrates a profound misunderstanding of thermodynamics. While the detailed interpretation of Genesis 3 and the physical consequences of the Fall are beyond the scope of this article, there is no physical evidence that chemistry and physics have changed in the last 13.7 billion years.

Theological Misconstrual of Entropy

One of the least attractive assertions of some evangelical theologians is that the universe must be described by “fallen physics” and that “in the beginning” matter behaved in a qualitatively different way. One of the most explicit statements of this perspective is given by Greg Boyd in *Satan and the Problem of Evil*:

Creation does not have to operate exactly the way it does. Chemicals do not *have* to interact with each other the way they do. Animals, weather patterns, geological plates, genetic codes, viruses and body cells do not *have* to behave the way they do. There is no known reason for why things *have* to die. Indeed, from a strictly scientific perspective there is no reason why there *has* to be a second law of thermodynamics. It is conceivable that the physical cosmos could have tended towards increasing complexity and design rather than degenerating towards randomness. Thus it is reasonable to ask why it does not. If it is all God’s handiwork, should it not operate differently? Science has nothing to say about this question.²⁰

This notion has no physical basis (there are no observations of “spiritual physics”) and no compelling theological basis, but it does have a visible community of discourse. The cognitive dissonance between the proclamations of the pulpit and the observations of physical reality creates a crisis for thinking Christians. Are theologians and Bible scholars free to assert such claims about the physical world in the absence of either observable evidence or specific scripture?

Is there a theological lesson to be learned from this thermodynamic analysis? Perhaps the lesson is that the Creator of the universe is more subtle than we ever imagined. The notion of a “blind watchmaker” is grotesquely crude when compared to the Creator of our universe. We have only begun to appreciate

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the complexity and beauty underlying our physical universe. John Polkinghorne has discussed the suppleness of our world, and its suitableness for a life of soul making.²¹

There have been persistent suggestions that the chemistry that is observed today is substantially different from the “ideal” chemistry that existed before the Fall. A proponent of the change in the principles of chemistry associated with the Fall of humans is Gilbert L. Wedekind in his book *Spiritual Entropy*.²² However, it is not clear what this spiritual chemistry would be like. Would chemical reactions be forbidden, since the chemistry of decay seems to exercise the souls of many of these theologians? Would equilibrium be forbidden, since the entropy increases as the most probable state is achieved? The whole notion of a “different” chemistry is without observational foundation and proceeds from a largely ignorant stance toward the present state of chemistry. The geology of the earth has been largely explained in terms of processes that are observed in the present or reasonably extrapolated from current phenomena. To suggest on theological grounds that any science would be different, without any physical evidence to support such a conjecture, is not likely to convince anyone and will certainly marginalize the author of such thoughts. Unless there is either clearly demonstrable physical evidence or compelling theoretical arguments, no scientist should welcome unwarranted theological conjecture about science.

Thermodynamics and Life

The area of science that seems to create the largest rebellion against the principles of thermodynamics is the study of life. Living systems are definitely not at equilibrium. Living organisms are slowly changing, highly nonequilibrium systems. The science of nonequilibrium thermodynamics is also a highly developed paradigm with a substantial empirical base and coherent key concepts.²³ The notion of fluctuations plays a central role. Biological systems are explicitly open and require a constant source of energy to remain viable. The chemical reactions of life are highly coupled and many feedback mechanisms are active.

There is apparently a theological notion that life ought to be “easy.” In an “ideal” (pre-Fall) world,

all creatures great and small would live in ease and harmony, and no perturbations would disturb their persistent life. The thermodynamic perspective is that all life is fragile, and that the miracle is not that death occurs, but that life ever occurred. It is so complicated and so far from equilibrium that only the most unlikely events or the direct intervention of outside agents could produce it. The notion that left to themselves (in isolation) nonequilibrium systems tend toward equilibrium sounds like a truism, but for some theologians, it is the smoking gun of the Fall, just as the microwave background radiation is the smoking gun of the Big Bang.²⁴

The current paradigm for the Big Bang proposes an ancient history that is even more out of equilibrium than we are today. The standard model of Earth science suggests an initial system unfriendly to the existence of life. When the earth changed enough, in response to both external and internal changes, water condensed and life appeared. There is no “evidence” of an idyllic period in the truly ancient past. The magnetic field of the earth reverses on a predictable and observable timescale. Is this the result of the “Fall” when it has been going on for millions of years in response to thermodynamic forces in the earth? Some theologians then resort to a separate Fall for the earth, perhaps brought on by the Fall of Satan.²⁵ But there is neither physical nor scriptural evidence for this. Suggesting that thermodynamics is “fallen” in our times just seems incoherent. What better system is being proposed when current thermodynamics has no known exceptions? Is there some revelation of a new chemistry that other Christians have missed?

One of the most important facts about living systems is that they are entropy generators. The processing of food is an irreversible process that produces entropy. The transport of chemicals into and out of cells is an irreversible process that produces entropy. Any process that involves viscosity, diffusion, or resistance leads to the production of entropy. Life is an inherently nonequilibrium, irreversible process!

In order for life to persist at all, the organism must have both conservative and evolutionary processes available. When the environment is relatively stable, the organism needs to count on the faithfulness of

biological chemistry to continue its existence. When conditions change, either the individual organism must have a mechanism to adapt, or the group of organisms must have enough biological diversity to manifest a successful pattern in some specific members of the group. Otherwise, the species will become extinct. It is not at all clear how changing the principles of thermodynamics will solve the problem of finite plasticity in every actual biological organism. It is sometimes asserted that in the distant past, animals did not die. There is no evidence for this assertion; it is just an unsupported theological deduction. It is more important to recognize that we are made of "dust." God did not create a "magical" world in which physics and chemistry were "different," but he did create one that could support life, even under difficult circumstances. Perhaps it is time to accept the fragility of human, or any biological, existence. God has chosen our actual world as the place of our sojourn. He will never leave us nor forsake us.

Strangely, some theologians invoke the second law of thermodynamics as an argument against the observed history of life on earth. They claim that the observed increase in "order" violates thermodynamics. Thermodynamics applies to equilibrium systems. Living systems are far from equilibrium and are explicitly open with regard to mass and energy transfer. The trajectory of a physical system through the nonequilibrium world can be truly bizarre, and many counterintuitive results are observed.

But good science starts with good observations. Denying the observations or trying to explain them away is not the way forward. A simple example is the crystallization of a liquid far below the equilibrium melting temperature. It is relatively easy to prepare a liquid in the metastable state well below the melting temperature. When the right fluctuation occurs, the system will start to crystallize (the waiting time can be from seconds to years). As the crystals grow, they release the heat of crystallization and the system warms up. If the liquid is completely isolated during this process, the energy stays the same. The spatial "order" of the crystalline state is higher than the liquid state, but the process proceeds until either the whole sample is crystalline or the temperature reaches the equilibrium melting tem-

perature, at which point the sample could be a mixture of liquid and crystalline regions. The Second Law assures us that since the isolated process did occur, the entropy change must be greater than or equal to 0. But the sample is now a crystal! It all makes good thermodynamic sense. Thermodynamics never contradicts actual observations.

Thermodynamics as Analogy

Since thermodynamics is such a successful paradigm, perhaps it can provide a guide to theology and point to a richer world of discourse. Classical thermodynamics focused on those aspects of macroscopic physical reality that could be observed and measured. An actual body of data that can be appealed to by any member of the community aids public discussion. I do believe that there is a body of observations that provide one of the aspects of theological reflection. The human stories of Jesus and the earliest Christians provide a potentially useful body of narrative episodes. The lives of Christians living under different political and economic conditions help us to discern those universal aspects of spiritual life that call for theological reflection. This knowledge can be subject to all the rigorous methods of the historical sciences, but without grist, the mill produces no flour.

The constructive task is to induce relationships that emerge from these narratives. Are there effective ways of living that have characterized Christian communities throughout the last two millennia? This body of theological reflection could perhaps produce what might be called a phenomenological theory of Christianity. Unless the more speculative or systematic theology can explain the actual history of Christianity, it is just as useless as a scientific theory that contradicts the known facts.

Classical thermodynamics is still a very useful subject, but eventually scientists became ever more eager to "explain" some of the more startling observations. Early speculations tried to use known paradigms and extend them to the new observations. Ultimately, this approach failed. An explicitly microscopic approach was required. The behavior of the microscopic world was then studied, and it was discovered that on short length scales and for light

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particles, the macroscopic laws were a poor predictor of what actually happens on a microscopic level.

Some have attempted to explain the phenomenological observations of Christianity in terms of a richer ontology than that of physical science. Is there any evidence that entities such as angels and demons actually exist? Narrative episodes in the Gospels suggest that they do. Does their existence provide an effective explanation for certain known phenomena? The writings of Paul and James suggest that it does. Statistical thermodynamics suggests that a consilience can be obtained if continued effort is expended in full view of both the macroscopic and microscopic worlds. The fictive chemical atoms of John Dalton (1766–1844) became the standard reality of Lord Rutherford (1871–1937). Is there a Lord Rutherford for Christianity? It is certainly worth the search. Christianity is much more than a set of propositions in a book; it is a Way of life that is visible to other humans. Many Christian phenomena can only be explained in terms of the “spiritual” dimension of human life. Just as the microscopic perspective enriched our understanding of matter, so the spiritual worldview is essential for our understanding of humanity.

Too many theologians are obsessed with “perfection.” One of the biblical insights about our “physical world” is that it is not a sphere of perfection (Rom. 8:22). It is a place of good (Job 5:10); rain is good. In a physical system, too little rain causes a drought; too much rain produces a flood. God used both of these calamities to deal with humans during history. Isaiah described God as one who created both blessings and “ra,” calamity (Isa. 44:7). The clockwork perfection preferred by some theologians was not “chosen” by God as the mode of our existence. Our actual existence is “messy.” But then, love is messy. And God is love (1 John 4:8). Thermodynamics can deal with macroscopic physical reality quite well, even though the microscopic reality is truly bizarre. It is incumbent on theology to deal as well with the actual reality of human existence and its relationship to God.

The essence of entropy is the multitude of possibilities that God has given us in this world. In a world of no entropy, there are no possibilities, except for one. In the conceptual world of neo-Platonism, the One was unique and fully separated from

humanity. In the conceptual world of the Bible, God is intimately related to humanity, through prayer and through Jesus. There are many possibilities in this universe of interaction. Changes in one aspect of spiritual reality lead to changes in other aspects. This sounds much more like thermodynamics than like entropy-less sterility at $T=0$. The God of the Bible is full of warmth and seeks to interact with living thermodynamic systems known as humans. Fluctuations constantly occur, and can shock or thrill us, but the promise of God is that the macroscopic end is predictable, even though the steps along the way may be on a more chaotic path. Theological discussions will be more accurate and insightful if they understand and take into account the God-given entropy of this world. ★

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Notes

¹Thermodynamics is an essential part of the educational experience of all scientists and engineers. I teach the subject to physicists, chemists, biologists, chemical engineers, civil engineers, mechanical engineers, and materials scientists.

²Two good examples of this broad paradigm for theology are *The Science of God* by Alister E. McGrath (Grand Rapids, MI: Eerdmans, 2004) and *Science and the Study of God* by Alan G. Padgett (Grand Rapids, MI: Eerdmans, 2003).

³Two prime examples are James Clerk Maxwell (1831–1879) and Lord Kelvin (1824–1907).

⁴Erwin N. Hiebert, “The Uses and Abuses of Thermodynamics in Religion,” *Daedalus* 95 (1966): 1046–80.

⁵Helge Kragh, “Pierre Duhem, Entropy, and Christian Faith,” *Physics in Perspective* 10 (2008): 379–95.

⁶The history of the development of the concept of energy is well told in *The Science of Energy: A Cultural History of Energy Physics in Victorian Britain* by Crosbie Smith (Chicago, IL: University of Chicago Press, 1999).

⁷A readable treatise on elementary particles by John Polkinghorne is *The Particle Play* (New York: W. H. Freeman, 1979).

⁸Macroscopic is often demarcated by the limit of visible resolution, 0.5 microns. Macroscopic also implies a very large number of particles, of the order of Avogadro’s number: 6.02×10^{23} .

⁹A classic modern standard text for the most general development of thermodynamics is *Thermodynamics: An Introduction to the Physical Theories of Equilibrium Thermodynamics and*

Irreversible Thermodynamics by Herbert Callen (New York: John Wiley & Sons, 1960).

¹⁰Albert Einstein was one of the major scientific figures who developed the paradigm of fluctuations and their relationship to macroscopic measurable properties.

¹¹William Thomson (Lord Kelvin) is generally credited with formulating the First Law of Thermodynamics in its present form.

¹²James Prescott Joule (1818–1889) was another highly devout English natural philosopher.

¹³A good collection of essays on this subject is *The Trinity and an Entangled World: Relationality in Physical Science and Theology*, edited by John Polkinghorne (Grand Rapids, MI: Eerdmans, 2010).

¹⁴Nineteenth century discussions of absolute zero often defined it as the temperature where all motion ceased. The advent of quantum mechanics led to the realization that even at T=0, the zero point kinetic energy does not vanish.

¹⁵The formulation of the Third Law of Thermodynamics is usually attributed to Walther Nernst (1864–1941) and is often called the Nernst Heat Theorem. The statement given above is due to Gilbert N. Lewis and Merle Randall in their classic book, *Thermodynamics and the Free Energy of Chemical Substances* (New York: McGraw-Hill Book Co., 1923).

¹⁶Philip Yancey, *The Jesus I Never Knew* (Grand Rapids, MI: Zondervan, 1995), 182.

¹⁷The formulation of the Second Law of Thermodynamics is generally attributed to Rudolf Clausius (1822–1888).

¹⁸Sir Arthur Eddington, *The Nature of the Physical World* (Ann Arbor, MI: University of Michigan Press, 1928), 73.

¹⁹Emmet L. Williams, *Thermodynamics and the Development of Order* (San Diego, CA: Creation Research Society Books, 1981).

²⁰Gregory Boyd, *Satan and the Problem of Evil: Constructing a Trinitarian Warfare* (Downers Grove, IL: InterVarsity Press, 2001).

²¹A recent book by John Polkinghorne, *Science and Religion in Quest of Truth* (New Haven, CT: Yale University Press, 2011), stresses the beauty and subtlety of the physical world.

²²Gilbert L. Wedekind, *Spiritual Entropy* (Fairfax, VA: Xulon Press, 2003).

²³Ilya Prigogine (1917–2003) received the Nobel Prize in chemistry for his development of nonequilibrium thermodynamics and its application to living systems.

²⁴Sean Carroll presents the evidence for the Big Bang theory in a pleasing and transparent way in his book *From Eternity to Here* (New York: Dutton, 2010).

²⁵Greg Boyd is especially clear in his advocacy of this position.

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James R. Nichols

Communication

The Science Professor as Pastor?

James R. Nichols

University professors attempting to use their professor roles as a ministry must adopt some approaches that allow them to deal appropriately with their academic responsibilities toward students while, at the same time, incorporate spiritual formation and soul care in the classroom, laboratory, or studio. One helpful model is to view the professor as having a pastor role, at least some of the time. Whether with individual students or groups of students, the professor as pastor should anticipate opportunities to introduce spiritual reflection incorporated with the academic material. Although the specifics will differ with each academic discipline, every academic course includes specific topics that lend themselves to spiritual reflection, if only briefly. The goal is not to turn the classroom into a pulpit, but to legitimize the professor and student activity as being of concern to God.

There are two groups of people that I envy. They are caricatures, I understand. But they do set some extremes for me. The first group consists of my preacher friends. Spiritual matters are not all they think about, of course, but it looks attractive to me to have a life in which my job is to study scripture, study those who study scripture, and to try to make sense of it all so that God uses me to draw others to him. And, I get paid for that—maybe not get rich, but I do not have to satisfy some other job-related performance responsibilities. It looks like the good life.

On the other hand, I envy some of my science friends who do not make any Christian claim. These friends get to plan experiments, collect data, read, write papers, and apparently do so without thinking much (if at all) about implications and conflicts other than science

disagreements. They do not have any apparent spiritual misgivings or church battles to fight. It looks like the good life.

Caricatures, yes, but these two groups do highlight the life of academic and spiritual tension for those of us who have chosen to try to live in both worlds.

I am nearing the end of my fourth decade as a full-time university biology faculty member. The first ten of those years were at a public institution, and the remaining years have been at a Christian university. During those years, I, like all others, have tried to figure out how to do my job well.

The first task has been to identify what my job really is. This is a fundamental concern. My academic responsibilities have been fairly clear. Appearing in my classes semester after semester are students either (1) interested in biology or something about science or (2) needing to fulfill some university science requirement. The course content

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for the two groups will logically differ: a student wishing to go to medical school needs information different than a music major taking his or her only science course. Furthermore, the nonscience major will probably enroll in a class with me only once—this is my only shot with this student. A science (or biology) major, however, may encounter me more than once before graduation. But my task with each student type is to combine my science background and my view of the current world in order to offer a course that includes some helpful, stimulating and, perhaps, convicting information, regardless of the student's goal in taking my class.

More perplexing, however, is how I am to function as a spiritual person in the student's life. Whether the student is a fellow believer or not, I have a responsibility from God to play a role in that student's life that draws him or her closer to God. Do not recoil from that statement as being too evangelistic. That is not the point. For every person I contact, I believe that I have a responsibility to leave that encounter with the person closer to God than before the encounter began. If they are in the same place with reference to God, I am troubled by that. And if they are farther from God after dealing with me, that is a serious criticism of my behavior.

As a Christian academic, regardless of my academic discipline, I am in the business of spiritual formation and soul care with my students. It is not sufficient for me to be simply a biology professor. It is not sufficient for me to be simply an educator, even an effective educator. Somehow I must include aspects of my instruction, guidance, and mentoring that surpass the academic discipline and reach into the eternal, even if only in a barely perceptible amount. Perhaps we need to move into the world of metaphor to investigate this tension.

Many potential metaphors have been proposed to describe the complexities of being an academic leader in a classroom or lab and, at the same time, being a person of faith. With each metaphor the roles of the instructor and student drop out in different ways. If we see the instructor as a guide, the student becomes a wanderer or searcher. If we see the in-

structor as a gardener, the student becomes a person of potential who requires nurturing and care as he or she grows. One of the common metaphors today (and most troubling to me) is the corporate model of education in which the instructor is preparing and delivering a product and the student is a customer. Spiritualizing that relationship is a real challenge for me.

If we take seriously the spiritual requirements of the academic life, the professor as pastor may be a helpful metaphor. Metaphors are just that, however—metaphors. They can be stretched to the point of being unreasonable, but there are aspects of the professor as pastor that may be instructive.

I make here a plea for a reflective life. I make here a plea for thinking before we act. Each one of us leads a life that involves far too much reaction rather than reasoned response. We just buy stuff; we just go places; we just say things; we just read, watch, listen to, and digest without appropriate reflection. As we encounter, especially, university students living in an instantaneous world, what can we do that will allow God to "filter in," in a palatable way? This is not a peripheral concern; it is fundamental to our role as adult Christians dealing with those not so far along the journey. And, for those of us in academia, this occurs with the backdrop of student concerns for career, grades, finances, and relationships.

My goal is to be more intentionally pastoral with my students. How this manifests itself, of course, depends on what I define as pastoral. The word "pastor" is a big word in scripture, encompassing such subideas as prophet, teacher, priest, witness, and shepherd. Trying not to be overwhelmed by the gravity of these images, those of us concerned about helping to spiritually form our students (in addition to instructing them in academic disciplines) search for some ways in which our own personal Christian stance fits into the word "pastor." This will take different individual forms, but it represents a unique role and opportunity to offer some soul care to students who have come (not by accident, I believe) under our influence.

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Pastoral Care and Students

Pastoral care for students can be either to individuals or to a whole group (such as a whole class). Its primary quality is that I move away from or past the purely academic to a personal spiritual level. I may not stay there long, but I do go down there for a while. This level involves vulnerability on my part, a reflection on my experience in the world as a Christian, my understandings of scripture, and my role as a Christian. On an individual basis, this is similar to counseling, perhaps, but it has a clear spiritual direction emphasis.

The reader from another discipline will have different potential topics as pivots, but I have found that there are science topics and nonscience topics that are excellent seeds for spiritual reflection, even if the time of reflection is brief.

1. Parts of my instructional responsibilities are in the biomedical ethics area. Clearly, there is a rich array of concerns here. Having students read some of the seminal papers in areas of abortion, stem cell research, genetic engineering, physician-assisted suicide, various reproductive technologies, managed health care, and others and then discussing such material is both troubling and instructive to students. A colleague from my past has described education as being subversive. Although perhaps overstated, each of us looking backward at our own education can see that truth. I have found it an exciting adventure to supply basic reading material to students and to process it with them. Once an atmosphere of Christian civility is established in the classroom (and that is very important), such discussions can be vibrant growth-producing opportunities for both students and professors. It is natural to infuse such discussions with pastoral comments.

A second pertinent area in my discipline is to deal pastorally with the topic of evolution and creation. A fair number of students, especially in a Christian institution, will enter the classroom with strongly held stances. Some are, frankly, terrified at the prospect of having an intelligent (they concede) Christian professor influence them away from a simplistic view of creation material. Others, because of a more rebellious spirit perhaps, carry chips on their shoulders in reaction to such simplicity. On this particular topic, as well as some others, I believe I can be most

helpful if I can defuse the topic a bit. Since this is a science class, students logically expect that I will try to lay out for them some good science. There is a lot of good science in evolutionary biology. Students need not be afraid of it. I have been fairly successful in identifying for students the aspects of evolutionary science that virtually all scientists accept. I try to identify for students that some have added a layer of philosophy to evolutionary biology, and although that may be quite interesting philosophy, it is not science. I have found it most helpful to consider the evolution/creation material in the second half of a course after I have established a pastoral relationship (at least partially) with the class.

2. There are many nonscience topics that are fruitful for pastoral consideration. If I am standing before a classroom of thirty students, I can almost be assured that a couple of those students are in deep grief about something in their lives. Their parents may be divorcing, their grandparents may be dying, they may have just broken up from a boyfriend or girlfriend. (I suggest that we older educators ought not be cavalier about the latter situation—this is serious stuff when you are twenty-one years old and, I believe, even more complicated because so many of these couples have been sexually involved.) Sometimes I will know about this grief in my classroom, but usually not. What I must do, then, is continue to play my academic role while acknowledging the lack of focus a student might have because of the current complications of life. And I need to verbalize that acknowledgment both in front of the class and in a private conversation if necessary. Often saying something pastoral in a larger group will stimulate a later personal opportunity to minister. “I felt as if you were actually speaking directly to me but you didn’t know it.”

In addition to the topics above are pastoral insights (given both collectively and personally) on academic honesty, other family circumstances, other sexual concerns, and—one of the most common—“I hate the church, but I love God. Actually, I’m not sure about anything.” The latter sets the stage for serious considerations of the paradoxical nature of Christianity in that it is a religion of individual response and relationship to God that leads instantly to a relationship with a community.

Some Concerns

If we are to take our ministry responsibilities seriously, there is certainly some legitimate pushback that we will receive. Much of this is entirely reasonable and deserves some forethought. Specifically, the professor as pastor metaphor sets up these criticisms.

1. A classroom is not a pulpit. We must not act as if it were. The students are paying tuition primarily to receive instruction in a specific academic discipline. If we fail to aid them in that goal, we are not doing what we are being paid to do. Having said that, however, we must be authentic with our students. On the first day of class, I tell my students that they should expect a rigorous academic course and that I expect academic excellence from them just as they expect it from me. I also tell them that there will probably be a few days when I come into the classroom with something on my heart that I will feel compelled to share with them. It does not happen very often, but it does happen.

2. There is an honesty concern. Most students incorrectly believe that, since we as professors are full-fledged adult Christians, we have pretty much figured out how to deal with the complications and paradoxes of faith. As we make pastoral comments, it might be embarrassing to us to realize that we are acting as if we understand some things that we most certainly do not. We may not feel legitimate in what we say.

As awkward as these times are, however, they themselves are teachable moments. I believe it is entirely honest to tell students that I am perplexed by something, that I have changed my mind about something, or that, frankly, something is a current challenge to my faith. I often remind students of the story in the Gospel of Mark (chapter 9) in which a father comes to Jesus with a health concern about his son. Jesus comments about how dealing with such matters is possible to those that believe. The father replies, "I believe, help my unbelief." Since that is where my faith journey often is, it seems reasonable to affirm that students may be there also.

3. There may be student resistance to dealing with anything other than the academic topic at hand. Science majors of various types in my classes usually

have clear career goals that involve achieving sufficiently high grades, an acceptable entrance exam score (for example, on the Medical College Admission Test), and a set of knowledge/information that will make them competitive applicants and students once they are admitted. They may resent any time, no matter how short, spent on what seems to them to be nonacademic items.

This seems to me to be a smokescreen, however, in light of the available time in a specific course. By creating a classroom atmosphere that is accepting and supportive of reasonable nonacademic considerations, the stage is set for serious academic work during the times we are on task in the classroom or lab. To be pastoral in a class does not mean that the academic standards are lowered for either students or professors.

4. Especially with individual student encounters, acting pastorally needs clear boundaries on confidentiality. When students express their personal or spiritual concerns, they have a right to expect them to be protected. They have come to us for wisdom, not to be taken advantage of. There are obviously gender issues that need boundaries during these student/professor encounters also.

5. The clearest tension I have with students is allowing them to be college students in the best ways but trying to move them past the more negative aspects of being college students. I was twenty-one years old once. There were some great joys of being twenty-one, but there were also some very difficult times. While I would like to be twenty-one again for the good aspects, I do not want to deal with the bad aspects again. At my current age, there are, similarly, good and bad aspects. Each age brings its own blessings and trials; no one age is better than another. It is unfair of me to want my students to see the world as I see it at my age.

On the other hand, as a more experienced Christian, I feel some obligation to try to help those behind me avoid some of the mistakes I made, or at least be more prepared for some of the realities ahead of them. They are primarily interested in constructing their knowledge containers. I am increasingly more interested in how their knowledge leads to wisdom.

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Conclusion

Let me take an unusual and, perhaps, off-putting turn in conclusion. I believe it is not too much to suggest that one role of professor as pastor is to introduce our students to, or to remind them of, their own mortality. Once again, I am not interested in pushing students to a level of life that they do not need to inhabit yet. This is not to be maudlin, but to be realistic. Students (and all of us) need an occasional reminder that life is finite. Biology students should grasp this easily. When I take students with me to deliver Meals on Wheels (often clients of advanced age or with significant health problems), it is appropriate to note with the students that each of us will look and act like that someday. When I take students with me to the hospice wing of the hospital, the message of life and death cannot easily be missed. This is different than the emergency department visit where the activity level, flashing lights, and sounds all seem very much alive. In the hospice area, the dominant features are ambient

light, care, and quiet. These are important lessons for younger people. They do not need to dwell on these matters, but they need to be aware of them.

A colleague of mine speaks of “prayerful teaching.” By this, he is addressing an approach to education whereby the learner, teacher, content, and teaching methods are informed by an ongoing dialogue with God. This is serious business.

One of my former professors noted in a faculty meeting that he was moved every fall by the recognition that all over the country, anxious hearts were looking toward our city and our campus because we held their most precious possessions. It is not enough simply to be educators for those students. We need to be people who draw them closer to God. ★

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BIOLOGY

LIFE'S X FACTOR: The Missing Link in Materialism's Science of Living Things by Neil Broom. Wellington, Aotearoa, NZ: Steele Roberts, 2010. 192 pages, notes, index. Paperback; \$29.99. ISBN: 978-1877577208.

One is hard pressed to escape the highly public clamoring that says science and religion have been and always will be at war. *PSCF* readers are well aware that the war is a manufactured one and that it is inaccurate to characterize science and religion broadly in this way. Reality reveals a relationship that is much more complex. The absence of war does not imply peace, however, and there are real and potentially heated debates in some areas of science and religion.

One particular realm of heated discussion occurs within philosophy, a potentially fruitful area of mediation between science and religion. On the one hand are atheists who posit Darwinism as the "universal acid" that dissolves all meaning and fuels the fire of their reductionist materialistic philosophy. On the other hand are Christian philosophers who claim that all meaning is grounded in God and (for some) that the Bible specifically dictates anti-materialism (usually, dualism). Ironically, both agree that materialism and meaning are antithetical, but because these Christians are committed to anti-materialism they reject evolution. Although less well known publicly, there is a potentially constructive middle ground composed of both religious and non-religious persons, who believe that there is an intermediate philosophical position between reductionist materialism and dualism, or that dualism and evolution are not mutually exclusive.

Neil Broom's *Life's X Factor: The Missing Link in Materialism's Science of Living Things* fits into that philosophical arena. Broom is a professor in the Department of Chemical and Materials Engineering at the University of Auckland and a Fellow of the Royal Society of New Zealand. Intellectually, I was very excited to read Broom's book, as its description anticipated a synthetic and forward-looking account of how philosophical principles of purpose, intention, and mind could be wedded with evolution. Furthermore, I sincerely appreciated his motivation in writing the book and his concerns regarding popular-level treatment of evolution. For instance, I agree that the mechanism of natural selection can be overused and misapplied to suit the desires of its employer. Also, science for a general audience

is too often written in an oversimplified and too optimistic manner, especially in the area of scientific origins. Last, it is true that the majority of popular-level science writers say that evolution is mindless, pointless, and impersonal and that this truth necessitates assent to atheism and its evangelical promotion. Nevertheless, despite my appreciation of these concerns and my enthusiasm in reading *Life's X Factor*, it is unfortunate that there are serious issues throughout and, as such, I cannot recommend the book.

Broom's thesis is twofold. First, the philosophy of "biological materialism" blinds its proponents to teleological qualities clearly observable in the living world. Second, authors such as Dawkins who believe that evolution is mindless and nonteleological really betray this when they write phrases such as "cells within a developing organism know where they are in the embryo" or that "cells explore their environments." Broom's solution is to revisit William Paley's natural theology and to revitalize vitalism, an ancient philosophical notion that the/some functions of an organism are due to a principle distinct from biochemical reactions, which is not describable by physical and chemical laws. This antimaterialistic belief was refuted in the nineteenth century with the advent of the germ theory of disease by Robert Koch and others as well as Louis Pasteur's disproval of spontaneous generation. Broom's supporting argument amounts to a vitalism of the gaps, which is not surprising considering his early work promoting intelligent design. Throughout the book, Broom attempts to highlight areas of biology that he says are not explainable by natural mechanisms and thus point to mind behind it. This is a flawed attempt to integrate within biology a long discredited and unnecessary doctrine.

Methodologically, my biggest issue with Broom's book is that he oversimplifies materialism. First, Broom makes no distinction between the methodological naturalism that is required for science and the metaphysical naturalism that *is* materialism. Second, Broom equates materialism with reductionism, ignoring a wealth of work on ideas such as emergence, holism or organicism, and philosophies that maintain high respect for science that address Broom's motivations for writing *Life's X Factor* in the first place. Claiming that materialism is necessarily reductionist is false and thus a straw-man attack. Broom does a disservice to his readers by not engaging with (or even mentioning) Christian philosophers who subscribe to nonreductionist materialism, such as Nancey Murphy and Kevin Corcoran. A better solution would be to engage with current philo-

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sophical ideas, especially emergence, which multiple disciplines such as biology, philosophy, psychology, and theology are all finding to be fruitful. Even the textbook that I use in my freshman-level biology class notes the importance of emergence in organisms and how different levels of biological organization interact with each other to produce the emergent properties Broom believes require an immaterial life force.

In addition to his inadequate treatment of materialism, Broom's arguments against it and for vitalism were not convincing. In multiple instances, Broom delves into antievolution rhetoric, which is fine by itself, I suppose, but distracts heavily from the overall argument he is trying to make. It is clear that he has an agenda when he uses terms such as mainstream naturalism, scientific doctrine, orthodox and establishment scientists; I was repeatedly frustrated at the hand grenades that he lobbed at my biologist colleagues and me. Broom's grasp of evolution and natural selection is unclear. He does not seem to understand artificial representation of natural selection in experiments or Dawkins's computer simulations, and he equates survival with teleological purpose. Broom also criticizes evolution by discussing chemical evolution and origin-of-life science, areas that are only peripherally related to biological evolution. It is not enough to make a case for vitalism simply by attacking evolution. One needs to make the argument that materialism (reductionism in particular) fails as a philosophy and that vitalism is a better alternative; Broom has not done this.

In summary, I appreciate Broom's motivations for writing this book. I also found his prose to be lively and fast paced. His use of figures and photos throughout made for an enjoyable read. However, I do not believe Broom's solution is the way forward. Greater engagement with philosophy and a respect for methodological naturalism and evolution is essential, not a revival of vitalism or the natural theology/intelligent design of Paley. Evolution by natural selection has such unifying explanatory power in all of biology. Can it do the same and illuminate other areas of inquiry such as art and aesthetics, philosophy, ethics, psychology, or religion? For those interested in a comparative, better, and more engaging treatment of these ideas by authors sympathetic to Broom's concerns, I recommend Conor Cunningham's *Darwin's Pious Idea* or Alvin Plantinga's *Where the Conflict Really Lies: Science, Religion, and Naturalism*.

Reviewed by Justin Topp, Associate Professor of Biology, Gordon College, Wenham, MA 01984.



ENVIRONMENT

SONG OF A SCIENTIST: The Harmony of a God-Soaked Creation by Calvin B. DeWitt. Grand Rapids, MI: Square Inch, 2012. 245 pages. Paperback; \$15.99. ISBN: 9781592557011.

From the onset, it is important to know that about thirty years ago, Calvin DeWitt changed my life when, as a brand new professor, I attended a CCCU (then CCC) conference on Christians and the environment. A week with Cal changed my focus as a young Christian in science from studying how God created the world to how Christians should care for God's creation. Since then I have had the pleasure of reading, talking, and listening to Cal in numerous venues, and I have always benefitted from those experiences. Therefore, it was with great pleasure that I learned of this, his latest book.

It is a fitting work after three decades of leading the evangelical ecological movement as an author, speaker, director emeritus of Au Sable Institute of Environmental Studies, and professor of environmental studies at the University of Wisconsin-Madison. This book is appropriate reading for anyone from high school age on, from scientist to observant hiker, from pastor to layperson, from liberal to conservative, as long as they come to its reading with an open mind. The experts must not expect a scientific or theological treatise, while the nonexpert in either area needs to be willing to do some careful thinking. The liberal must appreciate its adherence to and use of scripture and tradition, while the conservative needs to be open to its applying scriptural passages in exciting, new, and, I believe, appropriate ways.

Like most of my colleagues, I am fairly confident in both my scientific and theological background. However, I am constantly amazed at DeWitt's ability to meld these two areas of my life in ways that I have never imagined. Nowhere is this better illustrated than in his annotated version of Job 40 where he follows each verse describing "behemoth" with an elaboration of what God may have meant ecologically. Why have I, a Christian for over fifty years and a PhD for over thirty years, never thought of the behemoth as a frolicking hippopotamus in all the times I have tried to get my college students excited about God's creation? DeWitt delights us time after time throughout the book with a range of topics that illustrate the delightfulness of our world.

As the title *Song of a Scientist* would suggest, the major unifying thread DeWitt makes use of in tying these topics together is his life-long love of scripture, particularly the Psalms, and hymns learned as a child. In many of the chapters it works beautifully, even for a dull old left-brained scientist like myself. When he takes us along on his "field trips" and shows how creation, from the Neerlandia farm to the Michigan forest to the Andes of Ecuador worships the Creator, the message resonates deeply. In dealing with other topics, such as the "harmonizing" of science, ethics, and praxis or the "economic antiphony," it seems a bit of a stretch. However, this in no way detracts from the import of what he is saying or the unique way he has of "harmonizing" science and Christianity.

DeWitt does this in different ways in every chapter, making use of his childhood experiences, his work with the Township of Dunn, various conferences and workshops he has attended, and a multitude of other experiences. I found each to be compelling, informative, and thought provoking. However, the incredible diversity of methods, topics, locations, time periods, etc., created a feeling of discontinuity and confusion at times. At several points I found myself thinking that this was more a collection of separate essays that had been bound together, each one interesting and worthwhile, but together lacking sufficient connection. On many occasions, I also felt the need to flip back to a previous chapter as the author picked up a thread he started to follow several chapters before but which I had lost track of.

None of this, however, would stop me from highly recommending this work to any Christian, whether they are particularly interested in creation care or not. The author's love of God, his creation, scripture, and science are obvious on every page and highly infectious. His study of words, be they English, Greek, Hebrew, or Latin, moves me as few others have. It is astonishing that he, as far as I know, is the first to point out that the simple term "fossil fuels" is a misnomer, implying that by their very design and purpose they are meant to be used by humans as fuel rather than left as a carbon sink. Whatever you believe on the topic of global warming, such an idea must make one stop and think about what we believe, what we feel, and how we act toward God's creation. I found myself learning and thinking in this way throughout the reading of the book and plan on using much of the insights I gained from reading it as I teach my ecology courses to Christian students more interested in

entering professional schools than learning the songs of the spheres and worshipping their composer.

Reviewed by Scott S. Kinnes, Professor of Biology, Azusa Pacific University, Azusa, CA 91702.



THE CREATIVE DESTRUCTION OF MEDICINE: How the Digital Revolution Will Create Better Health Care by Eric Topol, M.D. New York: Basic Books, 2012. 303 pages, afterword, acknowledgments, notes, index. Hardcover; \$27.99. ISBN: 9780465025503.

The current financial and economic climate continues to push healthcare access, cost, and regulation into the spotlight of political debate and legal review. As a result, the medical community at large is feeling the pressure to make radical changes to comply with continuously evolving congressional demands and patient expectations. Such a transformation by means of radical innovation or "creative destruction," as termed by Austrian economist Joseph Schumpeter, is the foundation of Topol's exposé of a not-so-distant future when the frontier of individual genomic data, wireless physiologic biosensors, and personal health records rescue medicine, as we know it, from its current path toward fiscal self-destruction.

Creative Destruction begins with chronicling the major advances (cell phone, computer, internet, gene sequencing, and social networking) that have interconnected to form the current landscape that is poised to set up a "digital disruption of medicine." Following this introduction, Topol navigates through descriptions of the four principal digital arenas: genomics, wireless biosensors, imaging, and health information technology.

In discussing genomics, Topol likens current physicians to priests before the Gutenberg printing press, keepers of societal knowledge. He contends that patients as consumers should advocate for knowing and obtaining their own personal genomic data, and that they need to utilize and exploit this information to transform the "sclerotic" and "paternalistic" medical world from relying on cost-ineffective mass screening and population effect trials to focusing rather on the primacy of the individual. As both a physician and a professor of translational genomics, Topol skillfully steers through the challenging terrain of gene sequencing and pharmacogenomics. However, those without a scientific background may find it difficult to negotiate the forty-five pages

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dedicated to explaining the several types of genomic sequencing and their various impacts.

Although the genomic information in *Creative Destruction* may not be as easily digestible for some as found in other books (e.g., *The Language of Life* by Francis Collins), *Creative Destruction* finds strength in explaining the impact of intersection between the different digital domains. The concept of incorporating genomic data and internal nanosensors to detect circulating cancer cells long before they are seen in conventional methods, or the ability to sense a myocardial infarction and relay this to your smart phone, much like a car alerts you when your oil is low, may both seem like science fiction, but Topol creatively uses these and other examples to show that such innovation is well underway.

The final section of *Creative Destruction* is an appeal to reform the current environment of medicine and pharmaceutical industry by incorporating digital practices and open intellectual collaboration. Topol forecasts how physician education must also inevitably change. As more genomic insight is gained, fewer diseases will be labeled idiopathic. The labeling system of diagnoses will have to encounter a complete overhaul when diagnosis becomes more and more individualized with a deeper understanding of interpreting personal genomics, an area that many physicians currently feel unqualified for and perhaps are uncomfortable doing.

While *Creative Destruction* is not able to fully allay all fears and questions regarding (1) how to filter through the overwhelming data generated by genomic sequencing and continuous sensors, (2) how to ensure equal access for all to these resources, (3) the potential of eugenics, (4) protection of genomic data from authorities and corporations, (5) how and when the exorbitant upfront cost will offset current fiscal inefficiency, and (6) preventing the formation of “cyberchondriacs,” Topol does validate and recognize these and other controversial topics and makes an attempt to rectify them with the benefits he sees a digital revolution providing.

Whether you agree or disagree that creating a “virtual human being” by knowing the DNA data and viewing multiple continuous physiologic metrics in real time is ethical, moral, or beneficial, *Creative Destruction* is a well-written, systematic assessment for those who desire to understand how digital advancements are currently assisting the medical arena and in what areas industry leaders project them to be assisting in the near and distant future.

Reviewed by Matthew J. Koster, Department of Internal Medicine, Loyola University Medical Center, Maywood, IL 60153.



HISTORY OF SCIENCE

SCIENCE AND EASTERN ORTHODOXY: From the Greek Fathers to the Age of Globalization by Efthymios Nicolaidis. Baltimore, MD: The Johns Hopkins University Press, 2011. 288 pages. Hard-cover; \$55.00. ISBN: 9781421402987.

Judging by its title, *Science and Eastern Orthodoxy* is located in the field of scholarship known as dialogue between science and religion, in this case, science and Eastern Christianity. However, this book better reflects historical research in the interaction between faith and knowledge, theology and science, religion and politics in the ancient Greek-speaking Roman Empire, Byzantium, post-Ottoman Greece, and the modern Greek state.

The research by Efthymios Nicolaidis is very timely because, as is well understood in Orthodox circles and by the author himself (see pp. 197–202), Western historiography, either of the sciences or relations between the sciences and Eastern Christianity, is very poor. In most contemporary Western discussions of science and the early church, the references, in the best case, are made to Patristic sources before the fifth century AD followed by a huge gap until the time of Roger Bacon and Thomas Aquinas, through whose activities (and under the patronage of the Roman Catholic Church) the first universities in Western Europe were established. The obvious question as to why this reduced history completely ignores a nearly thousand-year-long period of Byzantine contributions to the debates on science and theology remains unanswered. This is the reason why this book by Nicolaidis is of paramount importance in our efforts to gain an understanding as to why the impact of Eastern Orthodox thought on science and its debates with theology was different and less articulated when compared to the famous clashes between new scientific ideas and church teaching in the West.

The first ten chapters of the book deal with the problem of appropriation of the sciences and science education in lay and religious institutions in the Greek-speaking part of ancient and Medieval Europe. This, I believe, is the most valuable part of the book, for it gives a detailed and well-documented account of the complicated religious and political stance concerning the sciences in Eastern Christian societies. Particularly, in chapter three, there is an interesting discussion of the role of the iconoclastic debates in terms of their impact on the

perception of the sciences and science education in Byzantium. This is an example of how some religious views (taken to their extreme), devoid of philosophical insights and having a disregard of historical achievements, can reduce the study of nature to a primitive and unscholarly level. On the other hand, the iconoclastic controversy, with its anachronistically narrow perception of nature, gave rise to a new impulse of learning and a certain revival of the meaning of the sciences under the influence of a humanism which reflected Hellenic roots (see chapter four and its expansion in chapters five and six). Nicolaïdis masterfully outlines the apogee of the Byzantine polemics about the sciences in chapter seven, which is devoted to the importance of *hesychia* (the practice of silence and quiet contemplation) for all Orthodox debate.

Nicolaïdis discusses the thought of St. Gregory Palamas in chapter seven. Palamas is important for historical Orthodoxy, not only because of his defense of acquiring knowledge of God through contemplation and intuition, but also for his teaching on the *divine energies* through which God can be known through creation. He advances an important point, namely, that the ascent to the Divine through creation is possible only if the dimension of the Spirit is taken into account. In modern parlance, this insight gives the study of nature a para-eucharistic dimension, breaking the symmetry between theology and science, which is often assumed in modern discussions. Reading this chapter will give the reader a good idea of the importance and indispensability of historical insight, so necessary for contemporary discussions of science and religion.

On a bit of a critical note: when Nicolaïdis (beginning in chapter eleven) turns to realms beyond Greek-speaking Orthodoxy (for example, Russia), the picture he presents seems to be rather brief and incomplete. However, this is understandable, since all the sources describing the polemic between Christianity and the sciences in Russia effectively originated at the end of the eighteenth century and are seldom available to Western scholars. This fact also concerns the broad discussions of Darwinism in the nineteenth century, as well as the numerous debates and publications about faith and knowledge in the beginning of the twentieth century. While this book deals with the contemporary situation in the Greek state, it omits any discussion of the situation in the Soviet and post-Soviet Russia, which is pregnant with events, publications, etc. In no way does this comment intend to create doubt about or diminish the quality of the book under discussion. I merely

want to signal the fact that when "Eastern Orthodoxy" appears in the title, one must understand that the book is mainly related to historical and contemporary Greek Orthodoxy. Perhaps a similar book should be written about the Russian Orthodox Church and its dialogue between Christianity and the sciences.

Another point: while Nicolaïdis gives a detailed list of references to original and secondary sources, the reader might wonder why a large amount of the literature on the historical interaction between Christianity and ancient Greek culture and science is not mentioned. Certainly more theological references are needed to document the relation between ancient philosophy and specific views of nature on the one hand, and Christian doctrine on the other. Although this was probably not the major aim of the book, the Eastern Orthodox perspective is loath to separate a purely historical account of events from the spiritual contexts and experiences of the fathers of the church and their heirs. I suggest that the book by Nicolaïdis is a complement to numerous books on the appropriation of Greek culture and philosophy by Christians, including such particular titles as the rather dated book by D. S. Wallace-Hadrill, *The Greek Patristic View of Nature* (Manchester University Press, 1968) or J. Pelikan's *Christianity and Classical Culture: The Metamorphosis of Natural Theology in the Christian Encounter with Hellenism* (Yale University Press, 1993).

Unfortunately, a purely historical assessment of events related to the sciences during the Patristic period does not take into account the fact that the sciences, considered as knowledge of the natural world, were always treated by the fathers of the church as part of a theological activity, as contemplation of the principles of the created world in order to praise the Creator. This reality suggests that the very definition of "science" (knowledge), as understood nowadays, is quite different from the one understood by Christians more than a thousand years ago. Definitely, an approach to knowing, originating in a deep spiritual attitude to God's creation, did not bring about new experimental advances, but, even for contemporary scholars, it offers hints and a certain methodology: not about how to *do* science, but rather how to *understand* science as a specific type of human activity. This lack of understanding of the proper meaning of science (as Heidegger expressed it, "science does not think"), namely, its *telos*, sometimes obscures the contemporary dialogue with theology. The fathers of the church, in spite of their limited interest in practical applications of knowl-

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edge, understood that clear existential purposes are necessary for the application of science, without which science does not make sense or may be potentially harmful for the human spirit.

In view of what has been said, one can point to a figure such as St. Maximus the Confessor, who is considered to be one of the most prolific and synthesizing theologians of the seventh century. For Maximus, knowledge acquired through experience is not valid because of the deception which has its origin in our senses (p. 44). However, in his theological writings, Maximus advocated the view that the contemplation of nature constitutes an indispensable part of the human ascent to God by removing the moral tension between the empirical (which is available through the senses) and the intelligible (which is grasped by the analytical part of the soul). It is obvious that as a monk Maximus did not participate in an empirical study of nature. However, he provides an invaluable insight about nature. Through the contemplation of nature, a person can infer the source of its contingent facticity, namely, the Creator. Maximus was not interested in particular mechanisms of nature and their effects, but it did not mean that he therefore disdained seeing nature as God's creation!

This position suggests that any history of the sciences, related to its interaction with Christianity, must be accompanied by the history of the appropriation of the sciences within nonscientific contexts. The characteristic stance of the Orthodox is that the question is really not about the literal treatment of scientific discoveries and theories, but rather about their appropriation for the sake of Christian ways of life and thought. This makes the contemporary dialogue between science and theology in the Eastern Orthodox perspective different from those purely academic approaches in the West.

In spite of these comments, this book provides the English-speaking reader with invaluable insights and references which cover nearly a continuous two-thousand-year period of interaction between faith and knowledge, science and theology, life and its understanding. This book will certainly make a serious contribution to existing scholarship on the history of the relation between science and Christianity. It fills an essential, and inadmissible, gap in research related to Byzantium, Eastern Europe, and Russia.

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THE CYBERNETIC BRAIN: Sketches of Another Future by Andrew Pickering. Chicago, IL: University of Chicago Press, 2011. 502 pages, index. Paperback; \$30.00. ISBN: 9780226667904.

Andrew Pickering discusses cybernetics as "a post-war science of the adaptive brain" (p. 6). Most of the book is not about cybernetics as a system of ideas or as a field that is still alive today, but rather it is an exploration of the work of several early and influential British workers in the field: Grey Walter (1910–1977), Ross Ashby (1903–1972), Stafford Beer (1926–2002), and Gordon Pask (1928–1996), with significant discussion of two other individuals: Gregory Bateson (1904–1980) and R. D. Laing (1927–1989). In the final chapter, Pickering states his purpose in writing:

The book is an attempt to rescue cybernetics from the margins and launder it into mainstream discourse ... By rehearsing the history of cybernetics and reading it in terms of a nonmodern ontology of not knowing and becoming, I have tried to convey my conviction that there is another way of understanding our being in the world, that it makes sense, and that grasping that other way can make a difference in how we go on. (p. 390)

Pickering sees several common characteristics in the work of these individuals. First, their work was characterized by a distinctive ontology—what he calls "ontological theatre"—which did not draw a dualistic distinction between people and things. Of relevance to this, most of the individuals (all but Beer and Pask) came to their interest in cybernetics through psychiatry, rather than by way of engineering and mathematics more commonly associated with the field. Finally, all were interested in the brain, not as an instrument of representation, but as an adaptive, performative instrument. However, their work went far beyond the study of the brain. Walter is famous for building artificial tortoises and for work on "flicker" and on biofeedback. Beer worked on operations research and biological computing, and eventually he applied cybernetic ideas to the Chilean economy as a consultant to Salvador Allende. Pask was involved with research on teaching machines.

One thing that keeps this book from being merely of interest to a student of the history of the field is the connections Pickering draws between the work of these men and ideas outside cybernetics that are still with us today. For example, two important areas of work in nontraditional AI were inspired by the work of early cyberneticists: Rodney Brooks (former director of the AI Lab at MIT and chief technology officer of iRobot Corporation) credits Walter's tor-

toises with inspiring his research with situated robots, and Warren McCulloch (another early cybernetics worker not discussed in the book) was the father of the field that evolved into the study of neural networks. Pickering also draws a connection between Walter's work on flicker and some of the psychedelic interests of the 1960s, and between Ashby's work and that of Christopher Alexander in architecture, Stuart Kauffman in biology, and Stephen Wolfram's "new science" (cellular automata and the study of complex systems). Finally, he draws a connection between the cybernetic work of Beer and Pask and their subsequent interest in Eastern spirituality.

The book also includes thorough references as endnotes, a broad bibliography, and a helpful index.

Reviewed by Russell C. Bjork, Professor of Computer Science, Gordon College, Wenham, MA 01984.



ORIGINS & COSMOLOGY

AMONG THE CREATIONISTS: Dispatches from the Anti-Evolutionist Front Line by Jason Rosenhouse. New York: Oxford University Press, 2012. 257 pages. Hardcover; \$29.95. ISBN: 9780199744633.

When was the last time you took a good hard look at yourself in the mirror? When was the last time you read a book that reflected an outsider's unflinching view of your faith and your attempt to integrate faith and science? In *Among the Creationists*, Jason Rosenhouse, a self-described atheistic Jew, takes a look at Christian responses to evolution through his experiences at several different conferences dedicated to creationism and intelligent design. He describes in depth the Creation Mega Conference at Liberty University in 2005, the Darwin vs. Design conference in 2007 (Knoxville, TN), and the Sixth International Conference on Creationism in 2008 (Pittsburgh, PA), as well as a trip to the Creation Museum in Petersburg, KY. Other smaller events provide short vignettes to begin the book, and are sprinkled throughout the book as well.

It should be no surprise that Rosenhouse is critical of creationism and intelligent design. However, unlike the "new atheists" who published several books in the middle of the last decade (Richard Dawkins, Sam Harris, Christopher Hitchens, and others), Rosenhouse seems to enjoy his one-on-one interactions with the fellow conference-goers, and his vignettes show him respectfully listening to them and, for the most part, being listened to respectfully in turn. His very attendance at the conferences and

his trip to the creation museum illustrates that he is at least open-minded enough to want to know firsthand what he is critiquing. As he writes in the introductory section, "... we still have to live together. Given this simple reality, it cannot be the worst idea in the world to try talking to each other once in awhile" (p. 15). "For all my disagreements with their views, I like being around people who are fired up about big questions" (p. 209). As such, the book produces a very readable description of what "we" look like to scientists who do not have a faith in God; whether "we" are young earth creationists (YEC), intelligent design (ID) proponents, or theistic evolutionists (or anything between).

The descriptions of the conferences and conference-goers rang true to me. I have attended only one YEC conference, more than a decade ago, but the format and atmosphere was similar to what Rosenhouse describes with enthusiastic audiences, relatively simple arguments in the presentations, and extensive bookstore sales. Indeed, the friendly crowd and welcoming attitude toward curious outsiders would also describe the ASA annual meetings—although hopefully not limited to simple rhetorical arguments! However, Rosenhouse makes several less than flattering observations repeatedly in the book. First, he notes in several different places that while conversing with "lay" creationists one-on-one is usually pleasant, the speakers and leaders are aggressively negative toward those who accept evolution.

One of the least endearing features of creationist discourse is the sheer magnitude of the charges they direct towards evolutionists ... They also feel the need to link evolution to every type of nastiness ever to afflict humanity. (p. 60)

Exhibits at the Creation Museum fall in this category, too.

It is fair to say that many of the exhibits demonize science and scientists. There is a line that is crossed when the desire to instruct your children leads to hostile and dishonest characterizations of large groups of people. (p. 137)

He is equally critical of ID proponents, particularly their inability to "put forth a clear theory of design, deduce its consequences, and then compare those consequences with actual data ... there is nothing here remotely helpful to my research" (p. 113). He also notes that ID proponents are equally as willing as YECs to quote scientists out of context and caricature their ideas (p. 91).

Second, Rosenhouse notes frequently and with regret that children and teens attending these confer-

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ences are essentially brainwashed into accepting a nonscientific view of the world. He observes,

... If their children went their whole lives without ever hearing about evolution or about views of morality different from their own, that would be no loss whatsoever. (p. 7)

This criticism is less than compelling, as all parents expose their children to the family's beliefs more favorably than to opposing viewpoints. In several places, he describes his preference to talk with teens rather than their parents, and his feeling that the teens are hungry to explore the standard scientific side of the issue more thoroughly. His feeling in this regard is almost certainly valid, as teenagers in our society generally explore and question family beliefs as they develop independence from their parents.

Leaving behind the atmosphere and rhetoric of the conferences, Rosenhouse takes time in several places to describe his conclusion that the YECs have a valid point in claiming that evolution poses large and potentially intractable problems to Christian belief.

From Darwin right through to the present, substantial numbers of Christians have had serious reservations about evolution. It is not at all clear their concerns are unreasonable. (p. 81)

He brings up no novel problems that have not been described elsewhere, but in contrast to many other critiques of YEC and ID, the theistic evolutionists do not get a pass in his book. The problem of a loving God as Creator, while evil is a real presence in our world and suffering is a reality in evolutionary history, is front and center here. Rosenhouse sympathizes more with the YEC view of a perfect creation and one human pair who then disobeyed God and caused the introduction of sin, suffering, and evil into the world than he does with other theological and philosophical treatments of theodicy. He notes the difficulty in reconciling evolutionary history with the doctrine of original sin, the weakening of the apologetic argument for God's existence coming from design in nature, and the diminished role of humanity in God's creation as a result of our evolutionary past.

Finally, he spends a reasonable amount of time pointing out common misuses or misinterpretations or misrepresentations of science used particularly by young earth creationists, but also by ID advocates. These critiques are not new, but he illustrates them accurately by reporting his personal experiences at these conferences.

Interestingly, the book shows the greatest respect toward the YEC speakers at the Sixth International Conference on Creationism.

We should have no doubt regarding the seriousness of the conference participants. We are not talking here about the professional creationists, the ones whose livelihood is spreading propaganda and corrupting school boards. We are talking instead about people who, so far as I can tell, are motivated by entirely the same considerations as mainstream scientists. They are trying to understand nature as best they can. (p. 188)

Because Rosenhouse shows respect to the adherents of these ideas he believes to be faulty at best, altogether false at worst, the book was far more effective in prompting my own thoughts about living as both a Christian and a biologist who regularly uses and teaches evolutionary theory. He backs up his observations with quotations from conference proceedings, and has clearly done extensive background reading in the evolution-and-faith literature as well as in Christian theology.

Several years ago, I participated in a discussion of Sam Harris's "Letter to a Christian Nation" with undergraduate students and science faculty at a Christian college. Rosenhouse's book would be a far better choice for that venue, as it has little vitriol but a significant critique of the worldview of those students and their professors. Nonscientists who are actively involved in these topics would also benefit from reading this true outsider's view of their activities. The respect that Rosenhouse shows for individuals with whom he disagrees is a proper starting point for each of us as we discuss the topic of evolution both within the church and in the world at large.

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PHILOSOPHY & THEOLOGY

TESTING SCRIPTURE: A Scientist Explores the Bible by John Polkinghorne. Grand Rapids, MI: Brazos Press, 2011. 108 pages. Paperback; \$17.99. ISBN: 9781587433139.

Formalities can be mystifying. Let's say someone is an ordained priest, an acclaimed professor with multiple earned and honorary doctorates, and is a Knight Commander of the Most Excellent Order of the British Empire. Which of the three associated titles—Rev., Dr., or Sir—would be trumped by the other two?

In the propriety that is all things British, it is the "Sir" that gets bumped. While this surprises American sensibilities, there is fittingness to it in the case

of the Rev. Dr. John Polkinghorne. He was knighted on the basis of his scientific accomplishments in concert with his Christian faith and vocation. Now in his eighties, Polkinghorne has written over thirty books on physics and the relationship between science and religion—works of such substance that he was awarded the 2002 Templeton Prize.

This short volume (just slightly over one hundred pages) contains Polkinghorne's considered reflections upon the Bible as the basis of Christian faith. The title plays upon Polkinghorne's status as scientist and suggests that this will be the crucial lens through which scripture is analyzed. That, however, is slightly misleading. The book really outlines Polkinghorne's pragmatic approach to scripture as he has wrestled with various issues over decades. His identity as scientist is not absent, but neither is it a rigorous matrix through which all of the Bible is analyzed.

Evangelical Christians from the west side of the Atlantic Ocean may find the mix of Polkinghorne's theological orthodoxy with contemporary science and modern historical/literary analysis of scripture somewhat unsettling, but its very pragmatism serves as a gentle tonic for the maladies of rigidity that American evangelicalism tends toward. On the side of orthodoxy, Polkinghorne affirms the two natures of Christ, the factuality of the resurrection, and the likelihood of the virgin birth. On the side of modernity, he considers humanity's evolutionary origins and the basic timeline of physical cosmology to be well established.

For the most part, the book is a set of observations about the way in which Polkinghorne has come to read the scriptures. The very brevity of the book is both its strength and its drawback. Polkinghorne sketches the assumptions and theological principles by which the scientifically literate reader can make sense of scripture as the foundation of the Christian faith. It is a quick survey and helpful in its accessibility. On the other hand, it moves so quickly through landscape known to be dense that one has a sense of being on aerial reconnaissance over tangled terrain. This is especially true of the middle chapters that survey the types of Old and New Testament literature.

Would everything appear so manageable and reasonable were one to get down in the undergrowth? Not if one is lulled by Polkinghorne's quintessentially British voice of eminent reasonability. One loses count of the number of sentences that aver "it is certainly the case that ..." or use the word "surely" to suggest irrefutability.

The early chapters address the character of scripture, especially its origins in religious experience. Revelation is progressive and therefore laden with ambiguity. Sacred history and knowledge of the divine unfold slowly over millennia. What in earlier texts is asserted about the ways of God with humankind is in later scripture revised or rejected. The changes, however, are directional, like evolution, and the mature picture of God, especially as we come to understand God in Christ Jesus, is rich and rewarding.

Where does Polkinghorne's identity as a scientist come through? It emerges in bits and snatches. On more technical issues, he frequently references his earlier writings. Sometimes images are drawn from the scientific realm. He suggests, for instance, that scripture is not divine dictation, but rather a lab notebook that contains human observations and reflections on religious experience. The metaphor, however, has little staying power. Indeed, Polkinghorne himself spends a great deal of time addressing the narrative character of scripture even though narrative and lab jottings are largely exclusive forms of writing.

In the last chapter, Polkinghorne highlights three texts that he finds especially profound—the prologue to John, the Christological hymn of Colossians 1, and the Pauline riff on the futility of creation in Romans 8. John's prologue seems to him to strike the perfect harmony between order and chaos, matching spiritual reality with the quantum world. Colossians 1 relates the work of Christ to all of creation, both physically and biologically. Romans 8 resonates scientifically with entropy and the necessary wastefulness of evolutionary process. No Edenic or moral Fall for Polkinghorne, but he certainly sees the felicity of an ontological fall into a world of freedom and possibility. This chapter alone, regardless of whether one agrees with Polkinghorne, makes the book a worthwhile read.

Reviewed by Rolf Bouma, Director of the Center for Faith and Scholarship, University of Michigan, Ann Arbor, MI 48104.

THE MIND AND THE MACHINE: What It Means to Be Human and Why It Matters by Matthew Dickerson. Grand Rapids, MI: Brazos Press, 2011. xxvi + 230 pages. Paperback; \$19.99. ISBN: 978-1587432729.

Frodo Baggins might be said to exemplify the value of virtue precisely because he freely chooses to do right at great cost to himself. Tolkien uses the con-

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cept of heroism, Matthew Dickerson argues, to show that free will to strive toward our *telos* differentiates humans from machines and allows the possibility of true reason and virtue. Dickerson, professor of computer science and environmental studies at Middlebury College, has written several laudable books about the truths contained in the fantasies of Tolkien and Lewis. In this work, he argues against naturalism, physicalism, materialism, and reductionism, using a stirring argument from the reality of human creativity, heroism (seen as virtue), art, and environmental concern. While the chronicles of Tolkien and Lewis are used to elucidate these concepts, the integrative dualism of Charles Taliaferro is given as philosophical warrant. These human values are set in contrast to the mechanistic ideology represented by Kurzweil's *The Singularity Is Near* and the *Matrix* films.

In the first section of the book, Dickerson presents the logical conclusions of several physicalist presuppositions and shows how the new atheists disguise these philosophical presuppositions as science. The abolition of creativity and virtue logically follows, along with machine-like life beyond freedom or dignity described by Kurzweil and Skinner. Arguments in this section, largely based on the work of Taliaferro and William Dembski, raise several useful points about the nature and operation of science itself. Science can have no answer for the problem of subjective experience, so although we know beauty and virtue to be true, they are not accessible to science. Dickerson also invokes J. B. S. Haldane's well-known argument about the unreasonableness of using reason.

The second section gives a theistic defense of both reason and science. Reason is not wholly explicable by natural laws and so must have a supernatural source (p. 160). Although our ability to reason is flawed because of our broken relationship to God, Christianity, he says, holds a high view of reason, and ultimately reason can be trusted because the source of reason is a divine Reasoner (p. 163). This appears to me to be a circular argument, although he invokes the miracles of Jesus as supporting evidence for the reasonableness of Christianity.

Taliaferro's interactive dualism is then presented as a more holistic form of dualism than that of Descartes. Rather than explicitly attempting a proof of dualism, Dickerson seeks to confirm its compatibility with the cherished values of creativity and ethical concern for others and for the environment. Although not explicitly stated in the book, Taliaferro believes the soul is cospatial with the body rather

than extensible in space; this view allows greater cooperation between soul and body than Cartesian dualism allows. Dickerson avers that Christianity teaches an *immortal spirit*, which is to be distinguished from the *Platonic soul* (pp. 156–7). This biblical teaching gives value to the body not found in Platonic dualism. Because Judeo-Christian dualism fully affirms the close connection between body and spirit, it holds both the physical body and the physical cosmos in high regard. This invalidates any denigration of the body seen in Platonic dualism or disregard for creation held by some Christians. In closing, Dickerson appeals to the reader to listen for the personal voice of this divine Reason.

Mind and the Machine provides a mostly well-crafted and accessible popular-level introduction to some of the naturalistic presuppositions often employed in philosophical arguments against theism. It also includes some useful Christian responses to atheism. I found the relative lack of references from either philosophy or theology and, in particular, none from science striking, even though the book is clearly not aimed at an academic audience.

As a neuroscientist, I expected that at least the chapter titled *Reason, Science, and the Mind as a Physical Brain* would consider some recent findings in neuroscience, but surprisingly neuroscience is not mentioned anywhere in the book. Any evidence for the ever-tightening link between the mind and the brain is omitted, along with the evidence that this interaction works both ways, namely, top-down and bottom-up. Downward causation of the mind on the brain would seem to be a useful addition in support of the antireductionistic argument Dickerson presents. He also fails to distinguish between strict naturalism and other broader forms which allow for the reality of consciousness and mental experience as an emergent from physical reality.

The use of the term *spirit* throughout the entire book in contexts in which most philosophers and theologians would use *soul* left this reviewer confused. Although he mentions the tripartite *soul* (p. xvi) rather than a tripartite person, and refers to the *mind* as being in the middle between *body* and *soul* (p. xvii), I could not decide if Dickerson differentiates between *soul* and *spirit*, or conflates the two. For example, even though Matt. 10:28 and 16:26 use the word *psyche* and not *pneuma*, Dickerson proposes that these verses deal with death of the *spirit*. He also states that the eternal *spirit* is to be reimbodied (p. 200) and that God breathed *spirit* into the dust to create Adam (pp. 130, 200). We are not told if this use of *spirit* is specifically intended to distinguish

his view from Platonic dualism, or if he is merely appealing to a popular evangelical audience.

My major concern is that Dickerson sets up his argument as if the only alternatives are substance dualism or eliminative materialism, necessitating a choice between the Shire and the Matrix. Of course we desire the heroism and beauty of Middle Earth, but is substance dualism the only compatible philosophy? Even among non-Christian philosophers there are other possible positions which might be relevant. For example, some of Chalmers's arguments could have been applicable even if he were not a theist. As a substance dualist, Chalmers holds that consciousness is a given fundamental of the universe, the same as gravity is. Gravity is physical, but its existence is also not fully explainable in physical terms. The only nondualist proposal Dickerson mentions is John Searle's position that consciousness is not ontologically reducible to brain processes even though it is completely caused by and realized in the brain. Dickerson lauds Searle's affirmation of the reality of consciousness, but dismisses Searle's reasoning.

A more relevant addition to the nonreductionistic argument, I believe, would be the concept of emergence, especially as developed by several Christians. Emergence can be either dualistic (e.g., Hasker) or entail development of a real mental reality from the physical brain. Judging by the number of recent articles in *PSCF* and *Science and Christian Belief* as well as recent books and symposia (e.g., <http://rsfs.royalsocietypublishing.org/content/2/1.toc>), top-down causality and emergence seem worth considering. Numerous Christian neuroscientists (e.g., MacKay, Jeeves, Brown, Newsome), philosophers (e.g., Murphy, O'Conner, Corcoran), and theologians (e.g., Polkinghorne, Green, Markham, Wright) affirm emergence of consciousness and soul without denying God's action in the universe. Jeeves's notion of dualism of aspects, "an intrinsic duality that we have to deal with but this does not need to be seen as dualism of substances," is widely known among Christians who study neuroscience or psychology. Soulishness and spirituality might be seen in terms of the *telos* God calls forth as our entire being in all its facets responds to him.

In speaking of substance dualism, N. T. Wright has compared the "god of the gaps" view of creation with what he calls a "soul of the gaps" view of personhood. Howard Van Till spoke of the "functional integrity of a fully gifted creation" which can freely participate in its own development. Discussion of the mind/body problem is ultimately a con-

tinuation of the discussion of how God works in the universe—through direct intervention or through the emergence, by God's action, of creative properties. Both scenarios hold God to be causally effective in the universe. Ultimately, however, both dualist and nondualists among us agree that the Holy Spirit is "everywhere present and filling all things" (as the ancient Trisagion prayer expresses), choosing to work with, in, and through the creation over which he hovers.

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JESUS CHRIST AND THE LIFE OF THE MIND
by Mark A. Noll. Grand Rapids, MI: Eerdmans, 2011.
180 pages. Hardcover; \$25.00. ISBN: 9780802866370.

A number of thorny issues confront Christians who wish to pursue serious study. What should we do when scripture seems to disagree with the results of our research? Is serious study compatible with serious commitment to Christ, given that evangelicals in particular have often shown some degree of suspicion toward academia?

University of Notre Dame Historian Mark Noll addresses these issues in his latest book, *Jesus Christ and the Life of the Mind*. Noll has been challenging fellow evangelicals to use their minds ever since his 1994 book *The Scandal of the Evangelical Mind*. In some ways, this latest book is a sequel to *Scandal*. But he goes much further than critiquing and challenging evangelicals in this book, providing a framework for motivating and executing serious study as Christians.

Since the reality of Jesus Christ sustains the world and all that is in it, so too should the reality of Jesus Christ sustain the most wholehearted, unabashed and unembarrassed efforts to understand the world and all that is in it. (p. 22)

The book finds its theological anchor in the creeds of our faith and in the great Christological texts of John 1, Colossians 1, and Hebrews 1. The first chapter examines the major creeds at length, laying the foundation for the rest of the book. Chapter 2 then looks at how Jesus Christ can provide motivation for serious learning. This chapter continues to build a foundation for the issues to be addressed later. Noll explores a number of scriptural texts on the preeminence of Christ and on various aspects of the Incarnation. On the first reading, I found the connections to academic study too abstract, more like devotional reading than a book about the life of the

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mind. I found the chapter much more significant when I returned to it after understanding where the rest of the book was going!

The material becomes more substantial in chapter 3 when Noll begins to offer some guidance for serious learning. This chapter presents four general principles, which are explored in greater detail for three specific disciplines of study in subsequent chapters. The four “stances” or “expectations” Noll presents are doubleness, contingency, particularity, and self-denial. He maintains that “once the nature of Christ’s person and work is grasped, and then the centrality of Christ for all things, these four stances should seem noncontroversial” (p. 45).

Doubleness: Through the incarnation, Christ is presented as fully human and fully divine. Our human reason tends to fight the tension of this “doubleness,” but it is at the very center of our faith. And “if the center of human history has [this character], why not at least some of the peripheries?” (p. 48). We can see God fully at work in things that are also fully natural or human processes.

Contingency: Most of scripture and most of Christology derived not from an abstract philosophical or speculative approach to truth, but from experiencing what God actually did in the world. Our faith is rooted in historical, experienced realities. In the same way that we know God best through experiencing what God has actually done, we should learn about the natural world primarily by empirical study.

Particularity: “Because God revealed himself most clearly in a particular set of circumstances and at a particular time and place, every other particular set of cultural circumstance takes on a fresh potential importance” (p. 55). The birth of Christ was a local event with universal meaning. Other particular events merit serious study because they too can be broadly meaningful.

Self-denial: Academics are vulnerable to sins such as pride and isolation. Focusing on the One who is gentle and humble in heart, and belonging to his Body will help us to approach study in a more self-less, loving, and modest way.

Three subsequent chapters get down to specifics: how should a scholar approach history, science, or biblical studies in light of the position that Christ is the One in whom all things hold together? Noll begins with historical study, his own field of specialty. By looking at how history is treated in scripture and at the historical event of the Incarnation,

he rules out both radical objectivism on the one hand, and postmodernist positions that disavow any meaningful connection to reality on the other hand.

The next chapter concerns approaches to science, and is likely of particular interest to *PSCF* readers. Noll discusses several historical currents that have shaped the assumptions for much of the current science-religion interface. He begins with a debate between Thomas Aquinas and Duns Scotus from the thirteenth century. Scotus argued that many descriptions can be applied to both God and humans “univocally”—with exactly the same meaning—while Aquinas held that the comparisons only held analogical value. Scotus’s position ultimately led to an assumption that is widely accepted to this day: that “once something is explained clearly and completely as a natural occurrence, there is no other realm of being that can allow it to be described in any other way” (p. 107). This position and later philosophical assumptions are set in contrast with the theme of doubleness discussed above. In Christ are united the fully divine and the fully human; in the world are united God’s sovereign providence and apparently natural processes. The world, “even in its most physical aspects, reflect[s] the wisdom and glory of God” (p. 112). Noll thus urges followers of Christ to be guided by empirical study rather than predetermined ideas when approaching the natural world. Conservative Presbyterian B. B. Warfield is presented as an example of excellence in holding both scripture and empirical science in the highest regard. In the study of biological origins, as in the authorship of scripture, Warfield argued for a *census* or coexistence between divine and natural causation, rather than putting them in opposition.

Lastly, Noll takes up the question of how a robust Christology shapes an academic approach to interpreting the scriptures themselves. This chapter is also of relevance to those of us interested in science and faith, because one of the key questions is how to approach passages of scripture that seem to contradict the conclusions of modern science. Following the example of the scriptures themselves, we should focus our study of scripture on Christ. We must also pursue understanding of historical contexts so we can understand the text’s original intent as much as possible, self-consciously critiquing our own assumptions in approaching a text. An important case study in this chapter is Peter Enns’s book *Inspiration and Incarnation*, which is held up as a good example of serious Christology applied to serious intellectual study of the scriptures (meriting attention even from groups who may disagree with Enns’s conclusions).

Jesus Christ and the Life of the Mind is above all a challenge to excellence in study. "For 'Christian scholarship' to mean anything, it must mean intellectual labor rooted in Christ, with both the rooting and the laboring essential" (p. 147). I warmly recommend the guidelines in this small book.

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LIGHT FROM LIGHT: Scientists and Theologians in Dialogue by Gerald O'Collins, S.J. and Mary Ann Meyers, eds. Grand Rapids, MI: Eerdmans, 2012. 256 pages. Paperback; \$35.00. ISBN: 9780802866677.

Light from Light is the fruit of two symposiums sponsored by the John Templeton Foundation in the ancient city of Constantinople (2009) and Oxford (2010). The editors divide the book into two parts with an extensive introduction. Six scientists, Part 1, and seven theologians, Part 2, were invited to explore the physics and metaphysics of light.

Scientific studies of light are based on experimental data that are unified by theories of light constituted by photons. This description presupposes and determines what light is, and so metaphysical questions regarding the nature of light that go beyond the bounds of science are not relevant to the success of such theories. On the other hand, metaphysics and theology are the two domains of the ontological context that delimit what is possible and so play a regulative role vis-à-vis the experimental sciences.

Humans use nonphysical, mental constructs to know and describe the whole of reality as physical/nonphysical/supernatural, and to use language to make sense of the whole of reality and to communicate and store knowledge. Objectivity is obtained in science by defining terms operationally and thus precisely. When dealing with the whole of the human experience, however, language is often cumbersome when expressing basic human thoughts and experiences that deal with other than purely physical concepts, particularly when considering the supernatural aspect of reality.

Part One

John Polkinghorne bases the existence of all on the creative and sustaining power of the infinite Creator, with reference to Gen. 1:3 and 1 John 1:5. He stipulates that a deeper understanding of the notion of

light in contemporary physics can serve as a further analogical source in discussions in theology. He reviews relativity, quantum theory, relationality, and cosmic properties. For instance, the quantum superposition principle is contrary to the Aristotelian law of the excluded middle, since one can superpose two states with opposite properties (e.g., spin directions). Similarly, the quantum paradox of the wave/particle duality helps us comprehend the human/divine duality of Jesus Christ. Polkinghorne contrasts the reality of photons established by detection via purely physical detectors, with the unseen reality of God, which is "detected" by humans.

Michael Heller reviews the historical development of the primeval atom hypothesis of priest and scientist Georges Lemaître. The creation of space-time is a consequence of the role that light plays in the origin of the universe, which Lemaître links to the first verses of Genesis. Nonetheless, Lemaître developed a "separatist" position whereby science and theology "are situated on two different cognitive levels, and even if they use the same words, the meanings attached to them are different." In particular, "the scientific concept of beginning has nothing to do with the religious idea of beginning, understood as the creation of the universe by God."

Andrew Steane discusses quantum entanglement, one of the most bizarre aspects of quantum mechanics. He emphasizes that knowing in the physical world is based on the interaction between (physical) things. A minor misprint in Eq. (2) carries over to the unnumbered equation that follows Eq. (3).

Markus Aspelmeyer and Anton Zeilinger discuss (local) "physical realism" whose failure would imply that the actual outcome of measurements is determined by the measurements themselves and that measurement performed on one physical system can affect the state of another physical system (nonlocality). The former is the measurement problem; the latter, that of quantum entanglement. They argue that these physical results may indicate "a change in our epistemology and our ontology." It is clear that studies of the quantum aspect of light give information of the physical aspect of reality and cannot provide ontological answers that deal with questions of existence. Therefore, the worldview considered by Aspelmeyer and Zeilinger must be a physical worldview rather than a worldview that encompasses the whole of reality.

Robert Boyd presents the effects of nonlinear optics on the question of the speed of light and the principle of causality, which is sacrosanct in science.

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The existence of subluminal, superluminal, and even “backward light” does not violate causality, because causality is determined by the information of a wave that is contained in the “front” of a pulse of light and not the associated group velocity. The information velocity determines causality, which is the speed of light in vacuum.

Marco Bersanelli reviews ancient and medieval perspectives on light as essential to human existence. In particular, he discusses Robert Grosseteste (1175–1253) whose cosmology views light as the source of every corporeity in nature, and Dante Alighieri (1265–1321) who described the natural properties of light. Both thinkers used the metaphor of light as the divine presence. It is remarkable how their incisive writings correspond to current knowledge of the cosmos (e.g., the accurate mapping of the cosmic microwave background radiation) and how contemporary knowledge can be used to illuminate further the metaphor of light as the privileged sign of the Creator.

Part Two

Gerald O’Collins brings forth the correspondence of glory and light with God in the Old Testament while in the New Testament one has “the light of the gospel of the glory of Christ, who is the image of God” (2 Cor. 4:4). His concern is how to understand the ultimate mystery of God and the Holy Trinity according to the lesser mystery that is light (i.e., Christ’s divinity as “Light from Light.”)

Kathryn Tanner considers the physical properties of light as a theological analogy for the Trinity, creation, and the presence of God. This she does via the study of church fathers John of Damascus, Gregory of Nyssa, Athanasius, Gregory of Nazianzus, and St. Augustine, as well as some theologians of the Middle Ages such as Thomas Aquinas.

Metropolitan Kallistos relates the complementary uses of light and darkness, each understood in four levels by the Greek fathers. Light is understood as physical, metaphorical or figurative, inward enlightenment, and spiritual. Darkness is understood as physical, metaphorical or figurative, purgative (passage from the senses to the spirit), and mystical.

David Brown alerts us to the combination of light and darkness for God in scripture, which is the content of Ps. 139:12. John Behr considers the Byzantine theology of light from “Let there be light” to “It is finished” (John 19:30) and the Christocentric rather than photocentric spirituality that it entails. Robert Dodaro concentrates on St. Augustine’s writings on

the different aspects of light: the spiritual (uncreated light; hence, God is Light), the nonphysical (God’s activity in the human mind), and the physical (studied by physicists). George Hunsinger delves into the relationship between created (physical) to uncreated (supernatural, transcendent) light in the thoughts of medieval and modern theologians, especially Aquinas and Barth. Aquinas uses the term “analogy” as a mode of discourse and not a mode of being; Barth emphasizes the miraculous and the mysterious.

This book deals with a rather difficult topic of how the creature, embedded in the creation, can know the Creator who transcends it, and what vocabulary may be used to describe the latter. Part One is much easier to learn and understand owing to the experimental nature of the study of light, whereas the theological discourse in Part Two is rather abstract and hard to follow. I recommend the book to those interested in understanding the Creator in terms of the creation; however, I am sure this will not be the last attempt of bringing together such diverse scholars to answer a question that is truly shrouded in mystery. Only knowledge of Jesus the Christ can give a glimmer of hope of who God is: “For there is one God, and one mediator also between God and men, the man Christ Jesus” (1 Tim. 2:5), and “If you had known Me, you would have known My Father also; from now on you know Him, and have seen Him” (John 14:7).

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THE WONDER OF THE UNIVERSE: Hints of God in Our Fine-Tuned World by Karl W. Giberson. Downers Grove, IL: InterVarsity Press, 2012. 201 pages, bibliography, notes. Paperback; \$16.00. ISBN: 9780830838196.

Karl Giberson is a prolific writer of science and religion and was asked to write a faith-friendly book about science, including its history and philosophy. The intended audiences are Christians with a limited knowledge of science. Science, apart from some philosophical distortions, strongly supports a Christian worldview, and this book presents an accurate, nonthreatening affirmation of this claim. The book excels in two ways. First, this huge subject is pared down to a two-hundred-page nontechnical book. This paring requires Giberson to be very selective in which topics to include. The guiding principles

should be to make the book an easy read with clarity, reasonable completeness, and without prejudicial distortion of the true relationship between science and religion. Giberson has the foresight and experience to make wise choices in accomplishing this task. Secondly, the book excels in its storytelling narrative. Beginning with the ancient Greeks and advancing through modern science, Giberson gives interesting and enlightening short stories of the more humane side of scientists. The stories display the importance of discoveries, showing how science has evolved and developed.

The fine-tuning of the universe (anthropic principle) is not presented until nearly the middle of the book. Giberson discusses many of the varied viewpoints of leading scientists on the significance of fine-tuning and gives an excellent rebuttal of the atheistic multiverse explanation of fine-tuning. He also provides an accurate description of what science is and its limitations, including some philosophy of science.

Giberson's main argument in the chapter on evolution uses evidence to argue that evolution cannot be fully explained by random chance. Near the end of the book he briefly touches on a broader worldview which goes beyond science and includes religion and other human experiences. He expresses the beauty of the natural laws as manifested in mathematics, raises the question of whether or not we live in the best possible world, and addresses the problems of evil, pain, and suffering. One conclusion Giberson comes to is the following:

If we find the world filled with wonders that move us spiritually or point beyond themselves or inspire us in ways not captured by our explanatory nets, we need not simply shrug our shoulders about why that might be. I think we can reasonably embrace the idea that there must be a transcendent reality in which these experiences are grounded. (p. 195)

There are a few minor blemishes in the book. As mentioned earlier, Giberson skillfully selects a boundary between topics to include and those not to include. For example, he discusses the Big Bang which signifies the beginning of the known universe, but he chooses not to mention that modern cosmological theories, including pre-Big Bang theories, consider the universe to be of infinite extent with no spatial boundary. This was a wise choice because its introduction would be a distraction from the main story. On one occasion Giberson does cross his self-imposed boundary to mention something that should have been avoided. In three separate places Giberson claims "Einstein

wouldn't accept quantum mechanics" (pp. 71, 127, 129). This claim is superfluous since Giberson leaves quantum mechanics (QM) out of his story. The only context in which QM enters is that the theory allows, but does not require, the possibility of multiverses. Secondly, this claim is false. QM is the most successful and accurate theory of humankind, and Einstein knew and confirmed this. QM is also the least understood theory; Einstein rejected the most dominant philosophical interpretation of QM and strongly suggested that QM is incomplete. Currently, both the interpretation and possible incompleteness of QM are still open questions involving extensive study.

Another blemish is present in Giberson's discussion of the fine-tuning of the universe. He points out that it is critical that neutrons are more massive than protons in order for atoms, which are essential for life, to exist. Giberson fails to mention that the neutron's mass must be in a very narrow range. If it were even 1% heavier than the proton, it would not be stable inside key nuclei, and multinucleon atoms would not exist. Instead Giberson says, "The decay of neutrons is not a big deal though, and losing them has no consequence for life" (p. 121).

I have one wish for this excellent book. If a second printing is forthcoming, Giberson should include a section on another kind of fine-tuning. Our earth and universe are fine-tuned for us to be able to observe and learn about our universe. No atmosphere known to exist, which is as thick as the earth's atmosphere, is as transparent to light as the earth's is. The earth is also strategically located in our galaxy, which allows us a reasonably good view of our universe. The universe is also fine-tuned to enable us to study it. It is mind boggling that we can observe and study our universe in historical slices all the way back to the Big Bang, billions of years ago. A reasonable conclusion is that God intended us to study and marvel at his creation and glorify him. Science can be considered a God-blessed occupation.

Reviewed by William Wharton, Professor Emeritus of Physics, Wheaton College, Wheaton, IL 60187.

WAR OF THE WORLDVIEWS: Science vs. Spirituality by Deepak Chopra and Leonard Mlodinow. New York: Harmony Books, 2011. 316 pages. Hard-cover; \$26.00. ISBN: 9780307886880.

This tome on a struggle presently in progress between two worldviews was written by the physicist Leonard Mlodinow and the physician Deepak Chopra who specializes in mind-body medicine.

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The book is a dialogue between the two authors on eighteen topics involving the so-called “war,” the cosmos, life, mind/brain, and God. On each of these topics, one of the authors makes some comments and then the other author replies. The result is a lively, entertaining, and informative exchange of ideas.

Mlodinow has a Weltanschauung or worldview typical of a physicist who does not believe in God, so many of his assertions are what one expects him to say. For example, he says, “Many predict the demise of this kingly and personal God as future science produces triumph after triumph” (p. 276). Chopra, on the other hand, has a very unorthodox worldview since he maintains that the source of religion is not God but rather consciousness. He further claims that consciousness is the force that directs evolution, which itself is “the tendency for the universe to unfold along steps of increasing intelligence” (p. 56). Chopra is a leader in the mind-body-spirit movement and is known for his activities and writings on mind-body wellness programs. He has many strong supporters, as well as many critics who find some of his ideas excessively unconventional.

There are discussions of how the universe emerged, and how it has evolved. Mlodinow, of course, presents the standard Big Bang and evolution approach based on natural selection. In contrast to this, Chopra claims that consciousness underlies everything in nature, and is the force that directs evolution. He further claims that the universe is also loving, creating, and evolving through consciousness. Some additional topics for discussion are the nature of life, what make us human, the connection between the mind and the brain, and whether the brain is a computer. God comes in for an extensive examination with the questions, “Is God an illusion?” (p. 245), “What is the future of belief?” (p. 259), and “Is there a fundamental reality?” (p. 277). In the Epilogue, Mlodinow defends science as the proper approach to reality whereas Chopra contends that science is making way for a new paradigm in which consciousness takes center stage. Mlodinow sums up by saying,

The issue that separates Deepak [Chopra] and me is not whether the universe has design, but whether something designed it, and whether it was designed for a purpose. (p. 108)

In contrast to these two worldviews, Christians look forward to the world eventually adopting a paradigm based on the teachings of Jesus Christ, in which the main purpose of creation is to provide an environment in which human beings can love, worship, and serve God by keeping his commandments.

This book can make available to *PSCF* readers many important insights into what the secular scientific public thinks about God and various other fundamental questions of our existence. In order to campaign to bring the world to Christ, it is important for Christian scientists to understand the motivations and thought processes of their secular scientific colleagues. This book can provide them with that.

It is a very favorable sign that a scientist of Mlodinow’s eminence and convictions is willing to have a serious dialogue with a colleague of Chopra’s viewpoint on the topic of spirituality. There is no doubt that the world at the present age has been experiencing a war or conflict between atheistic/materialistic secularism versus religion based on belief in and reverence for God. Leonard Mlodinow is certainly an appropriate spokesman for the former point of view, but in my opinion Deepak Chopra is far too unorthodox in his approach to be an appropriate spokesman for the latter point of view. He says, for example, “We must free ourselves from the burden of religious dogma” (p. 261).

A book of the present variety more realistically characterizing this “war” could be a useful thing to have. To be realistic, the defender of the viewpoint based on spirituality should not be someone like Chopra who claims that organized religion has discredited itself, but rather someone who is a firm believer in Christianity. After all, more than 30% of the people now living are Christians! This would provide the opportunity for a Christian scientist to explain the Christian Weltanschauung of how God not only created the material universe, but also made human beings in his image and likeness, sent us Jesus Christ to be our Savior and our Redeemer, and provided us with the scriptures to be our guide to living and worshiping.

In summary, this book provides valuable insight into the thought processes and viewpoints of typical scientists whose ideologies are of a materialistic and secular variety. It could be an important book in the hands of a faithful Christian who has a need to better understand the secular-materialistic viewpoint. However, for most scientists in the Christian tradition, there is no need for this, so reading this volume is not recommended for them. They would find it a rather disheartening experience.

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ENGINEERING EDUCATION AND PRACTICE: Embracing a Catholic Vision by James L. Heft, S.M. and Kevin Hallinan, eds. Notre Dame, IN: University of Notre Dame Press, 2012. xix + 247 pages, index. Paperback; \$34.00. ISBN: 9780268031107.

"No one is so naive as to think that there might be a special Catholic insight into thermodynamics ..." So states the first paper in this intriguing collection. The statement is surely bolstered by the scarcity of literature treating the integration of Christian faith with the discipline of engineering. Tantalizing bits appear in related discussions exploring the relationship between science and Christianity. More fragments arise when the focus expands to include technology, though authors often skip from scientific knowledge to technology without any consideration of the creativity and design an engineer uses to meld constituent ideas into working technological products. Examples of this conversation include works by Ian Barbour, Jacques Ellul, Egbert Schuurman, and Albert Borgmann. Two books of particular note are *Responsible Technology*, ed. Stephen Monsma, and *Beyond Paradise*, by ASA member Jack Swearengen.

The literature covering the subcategory of Christian engineering education is even slimmer, surprisingly so, given the dozens of Christian colleges and universities that offer engineering. Unfortunately, faculty in these programs have largely limited their scholarly dissemination to secular venues such as publications of the American Society for Engineering Education, only obliquely touching on faith issues by writing about ethics, service-learning, philosophy, and sometimes the liberal arts. Writing that more explicitly considers faith and engineering has found a home in only a few publications favorable to such thinking. The Christian Engineering Education Conference has provided seven peer-reviewed proceedings since 1999, and at least two germane articles in *Christian Scholar's Review* have appeared in the last decade. They are "Towards a Christian Theory of Technological Things," by Lambert Van Poolen (Spring 2004: 367–78) and "The Challenge of Vocation in Engineering Education," by Byron Newberry (Fall 2005: 49–62). The March 2012 theme issue of *PSCF* was also devoted to responsible technology and issues of faith.

Given the dearth of published work on the topic, I was delighted to receive this book featuring ten

conference papers that have been edited into chapters and divided into four sections. The editors complement each other. Heft is not an engineer, but a theologian interested in how Catholic faith relates to other intellectual traditions and disciplines. Hallinan is an engineering educator, though his previous publications have been primarily technical, not Christian perspectival pieces. The collection's authors are mainly, but not all, from Catholic traditions. Nevertheless, readers from across a variety of Christian traditions will find the book useful, particularly those who teach engineering in faith-based institutions.

I found much to like in this book. While many secular institutions of higher education have diffusive mission statements, many faith-based institutions couch their institutional goals concretely within the tenets of their faith. However, few engineering educators have articulated how that Christian mission plays out specifically for their discipline. This is the first published book-length treatise to explore the connection of Christian faith from a Catholic perspective within the domain of engineering. It is a serious attempt by these educators to apply the mission of their institution to the teaching of engineering. For the most part, it succeeds. The authors focus on Catholic social teachings as the most relevant part of their faith tradition in carrying out the task of integration. They recognize that engineering provides a number of tools to better pursue the Christian vocations of caring and social justice—vocations that can advance Christian witness. The virtue of humility is evident throughout the collection of papers. The authors do not pretend to have an exclusive hold on the truth, but modestly propose some important directions to explore. Service-learning and vocation are two common themes.

While the book is an excellent beginning, it should have further developed the central issue of integration rather than squandering space on peripheral issues such as the logistics of a seminar or a particular institutional description resembling marketing literature. The authors wade into the water of Christian faith and engineering synthesis, but stay close to shore rather than diving in deep. They go as far as suggesting that the concepts of one discipline can aid in understanding the other by providing a different perspective, but not so far as to suggest that one discipline could fundamentally change the other. The narrowing of vision caused by disciplinary silos is evident here. The authors do identify some boundaries (e.g., between theology and technology), speaking of relationships between them and of their

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individual contributions to “issues at their boundaries” (p. 124), but they do not suggest that faith not only laps at the boundaries, but also permeates every discipline. The authors appeal to some relevant literature, such as Catholic social teaching, but they do not look beyond their immediate scholarly neighborhood. Engaging more previous work would have given substance to their stated desire of wanting to establish solidarity with other intellectual traditions (p. x).

Some of the authors see engineering as a neutral tool in service of Christian mission and see its product, technology, as a simple means whose value is judged solely by the end it accomplishes. Schaefer and Heidebrecht, in their chapter, contradict this view: “... particular technologies are far from neutral. Technologies not only embody the values of their human creators; they also encourage the adoption of particular values ...” (p. 130). They do not go on to develop this idea, yet this point is crucial. Engineers do make numerous choices in designing technology—choices that are not merely mathematical calculations with singular solutions. In real-world technology design, the product is the result not only of mathematical and scientific considerations, but also of trade-offs between cost, reliability, sustainability, risk, fitness, and more. Thus while most of the papers in the collection recognize the importance of seeing the bigger picture (e.g., advocating for system thinking, or liberal arts, or broad-mindedness), they do not sufficiently recognize that Christian faith speaks directly to the prioritization of decision criteria in the engineering of technology. If design decisions are made with explicit recognition of broader principles, then technological products can serve justice, promote community, and care for creation.

As expected in a collection of papers on a challenging topic, one can find diversity in approach and methods, and even find contradictions. I am grateful that the editors chose to leave in these differences, thus providing us better insights into the richness of the topic. Engineering itself uses the diverse views of teamwork to successfully solve problems. Christian engineers can and do use diverse viewpoints to better understand God’s will for how to do their work. One such disagreement embodies the book’s central question: to what extent does Christian faith impact engineering? This review began with a quote from the one extreme—Heft writes in the first paper of the collection,

No one is so naive as to think that there might be a special Catholic insight into thermodynamics or

a Marianist take on hydraulics. Statics is statics, whether you are talking about a cathedral or the world headquarters of National Cash Register. (p. 20)

At the other extreme, Hallinan and Pinnell (in a later chapter) offer multiple possibilities of a “Catholic thermodynamics.” Their suggestions include the following: to expand interdisciplinary interaction so that other disciplines help flesh out the context of the problem, to deepen understanding through critical thinking and epistemology, and to articulate goals and priorities by formulating definitions of “best.”

Let me suggest a few more ideas to add to this good starting point. First, as mentioned earlier, technology is not neutral, and thus we can apply biblical principles directly to the engineering design process—principles such as stewardship, justice, and love. Second, not only is the design of the tool biased, but the use of the tool is also nonneutral. Thus, engineers ought to encourage proper utilization of technology. (Some of the papers in the collection do imply this direction, though a more direct application of scriptural guidelines would be helpful.) Third, as in the natural sciences, we can admire our Creator’s fingerprints in his creation. The study of thermodynamics can illustrate some of “God’s invisible qualities—his eternal power and divine nature,” which the Apostle Paul tells us “have been clearly seen, being understood from what has been made” (Rom. 1:20). Fourth, as a profession, engineering already is guided by codes of conduct and ethics. A fruitful area of further research would be to explore how professional integrity can be connected with the tenets of Christian faith.

A fine start on a needed topic, this book will be helpful to Christian engineers and technologists, particularly for educators at faith-based institutions.

Reviewed by Steven H. VanderLeest, Professor of Engineering, Calvin College, Grand Rapids, MI 49546. ★

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