Paper Title: Radical Heterodoxy in Science and Radical Orthodoxy in Christianity:
The Implications of Wolfram's Revolt in Science for Radical Orthodoxy in Theology

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Abstract:

Aside from relative backwaters here and there or except in major profile cases, cries of "heresy" are heard less often in Christianity today than in the past. But in an ironic turn of events, cries of "heresy" are now more newsworthy in science. The most notable heretic in contemporary science is Stephen Wolfram. Wolfram's central claim is that algorithms are at once simpler and more powerful than equations.

Wolfram tries to convince us that most advances in traditional modern science involved finding a shortcut that allows us to determine the outcome of a system's behavior without calculating each step of its development; such equations express the computationally reducible. Since most scientific activity moved to northern Europe after the Renaissance and later the Counter Reformation, the idea of the equation progressively supplanted the older Mediterranean idea of the algorithm as the pivotal computational principle in science.

But the rise of complexity studies has documented the diminishing returns of equation-based conventional science. It is remarkable, in fact, how little can be explained scientifically: turbulence, American politics, and epilepsy, for example. Wolfram argues that equations cannot usefully help us model such phenomena. Instead, Wolfram urges us to abandon equations if we wish to model complex phenomena and embrace algorithms in general and computer simulations with cellular automata in particular. Cellular automata simulations of complex systems turn out to be computationally irreducible.

Radical orthodoxy (RO) in Christian theology is a "post-secular theology" that has been expressed most notably by a trinity of writers, John Milbank, Graham Ward, and Catherine Pickstock. Several central ideas characterize RO. First, 20th-century modernism, inspired most of all by the Enlightenment, is in its death throes. Modernism assumed, among other things, that an exact picture of the material world is possible, at least in principle. We know now our epistemic situation is much more dire.

Second, what might be called the "secular consensus" is also dying. As Jeff Sharlett has commented, "the logic of secularism" is dissolving. Post-modernism has successfully derailed the philosophical and cultural consensus that provided a foundation for modernism. Foundation talk is now seen as irremediably quaint. Third, post-modernism itself has turned out to be a self-destructive movement. There is no foundation either for modernism or post-modernism.

Fourth, RO argues all that remains is language expressed in communities. Indeed, the logos of God is the only certainty that can withstand all the limitative results from the twentieth century. More specifically, Pickstock argues that the Western philosophical tradition itself lives within the liturgy of the church and the liturgy, in fact, is the only context in which it can live. Notably, all human attempts at knowledge and understanding must be rooted in theology.

This paper explores the implications of Wolfram's emphasis on program and computational irreducibility for RO's emphasis on liturgy and theology. Program will be argued to be the

computational analogue in science to liturgy in Christian community. Each involves irreducible, step-by-step work to create models for problems and contexts for meaning. I believe that some light can be cast on how science's relationship to Christianity should be reframed.

Biography:

Larry Crockett is Professor of Computer Science and Director of the Honors Program at Augsburg College, Minneapolis, Minnesota. He is also a priest in the Diocese of Minnesota and serves part-time at St. Mary's Church, the oldest Episcopal Church in Minnesota. He is the author of two books, *Universal Assembly Language* (McGraw-Hill) and *The Turing Test and the Frame Problem: AI's Mistaken Understanding of Intelligence* (Ablex). He is one of the co-authors of *Teaching and Learning in Honors*, published by the National Collegiate Honors Council. He has authored more than twenty-five articles in a variety of publications, ranging from *Computer Language* to *Quodlibet*. At Augsburg he teaches courses in computer science, the Honors Program, religion, and philosophy. He is a past-recipient of a Templeton Course Development prize and has been principle investigator for a number of National Science Foundation grant projects.

Paper Text:

Introduction

We usually associate the term "heretic" with religion and more specifically with doctrinal squabbles in the history of Christianity. The word "heresy" dates to a French rendering of the Greek *hairetikos* which mean's "able to choose." Perhaps surprisingly, religion and science moved in opposite directions with regard to the relation of orthodoxy and heresy in the twentieth century. Whatever doctrinal consensus that existed in Christianity largely dissipated in the twentieth century under sundry historical, exegetical and cultural pressures. Perhaps the most notable Christian embrace of pluralism in the twentieth century, Vatican II, occurred at the largest center of enforced Christianity uniformity, Rome. By contrast, most notably exemplified by the rise of textbook science, a significant amount of consensus emerged in science during the course of the twentieth century. Textbooks have become important in science education since enough consensus exists for textbook accounts of the "web of belief" in specific sciences. As an enforceable orthodoxy in Christianity declined, as a result, an enforceable orthodoxy in science developed.

Aside from relative backwaters here and there or except in major profile cases, crises of "heresy" are therefore heard less often in Christianity than used to be the case. But in an ironic turn of events, cries of "heresy" are effectively more common in science. The most notable heretic in contemporary science is Stephen Wolfram. Wolfram has argued over a period of twenty years that contemporary science is fundamentally mistaken and must be recast if it is to emerge from what he takes to be its current quagmire.

Wolfram's central claim is that algorithms are at once simpler and infinitely more powerful than traditional equations. An algorithm can be correlated with the prescribed movements of the liturgy while equations can be correlated with the Protestant preference for the spoken Word; *sola scriptura*, of course, was the shibboleth of the Reformation. Notably, for Wolfram, the algorithm is mightier than the equation. Since most scientific activity moved to northern Europe after the Renaissance and later the Counter Reformation, the idea of the equation progressively sup-

planted the older Mediterranean idea of the algorithm as the pivotal computational principle in science. We can consider an equation to be a precisely defined word.

Wolfram wants us to do a transplant at the heart of modern science, replacing equations with programs. To appreciate how radical Wolfram's revolt is, we should consider his comment about natural selection: "Most of the most obvious features of complexity in biological systems arise in a sense not because of natural selection but rather in spite of it" (*A New Kind of Science*, p. 396). Wolfram tries to convince us that most advances in modern science involved finding a shortcut that allows us to determine the outcome of a system's behavior without calculating each step of its development; equations express the computationally *reducible*.

But the rise of chaos and complexity studies has documented the diminishing returns that have characterized conventional science in recent decades. It is remarkable, in fact, how little of what we experienced can be explained scientifically: turbulence, the weather, the stock market, cascading power outages, epilepsy and schizophrenia, to name just a few examples. Wolfram argues that equations cannot usefully help us model and understand such phenomena. Indeed, he can take solace in the decline of importance in contemporary mathematics of the notion of proof and in Gödel incompleteness; most of the interesting theorems in mathematics may turn out to be unprovable in any case.

Instead, Wolfram urges us to abandon equations if we wish to model complex phenomena and embrace instead the algorithm in general and computer simulation with cellular automata in particular. Cellular automata simulations of complex systems turn out to be computationally *irreducible*. Such simulations must be given their free run as we replace proved equations with unprovable, unpredictable "empirical mathematics."

Radical orthodoxy (RO) in Christian theology is a "post-secular theology" that has been expressed most notably by a trinity of writers, John Milbank, Graham Ward, and Catherine Pickstock. Several central ideas have been advanced by these writers. First, the modernism inspired most of all by the Enlightenment is in its death throes. Modernism assumed, among other things, that an exact picture of the material world was possible, at least in principle. We know now that is not possible. Owing to such limitative results as underdetermination in philosophy of science, it can no longer be hoped that logic and evidence alone can pick out true scientific theories. Our epistemic situation is much more dire.

Second, what might be called the "secular consensus," is also dying. As Jeff Sharlett has commented, "the logic of secularism" is dissolving. Post-modernism has successfully derailed the philosophical and cultural consensus that provided a foundation for modernism. Foundation talk is now seen as irremediably quaint. Third, post-modernism itself has turned out to be a self-destructive movement. There is no foundation either for modernism or post-modernism.

Fourth, radical orthodoxy argues all that remains is language expressed in communities. For RO, the logos of God is the only certainty that can withstand all the limitative results from the twentieth century. More specifically, Pickstock argues that the Western philosophical tradition itself—at its best—lives within the liturgy of the church and the liturgy, in fact, is the only context in which it can live. Indeed, all human attempts at knowledge and understanding must be rooted in theology.

This paper will explore the implications of Wolfram's emphasis on program and computational irreducibility for RO's emphasis on liturgy and theology. I will argue that program can be taken to be the computational analogue in scientific exploration to liturgy in Christian community. Both involve step-by-step work to create solutions to problems and contexts for mean-

ing such that considerable light can be cast on how science's relationship to Christianity can be reframed.

I. Radical Heterodoxy in Science: Wolfram's Heresy

Wolfram's *A New Kind of Science* has been justifiably criticized for an unprecedented hubris. He's the *enfant terrible* of contemporary computer-based revisionist science. Many reviews of the work have curtly dismissed the significance of his work. *A New Kind of Science* (hereafter, *ANKS*) is arguably heretical in the classical sense: he is on to some captivating ideas but has taken them to be a larger part of how we understand science than his argument for them warrants. Taking program instead of equation as the fundamental way to represent and explore the world is a new kind of science, certainly, but modern science is not just a practice or a set of attitudes, it is an establishment with an entrenched orthodoxy that does not take kindly to this modern-day Luther's full frontal assault.

Wolfram's central claim is that algorithms are at once simpler and infinitely more powerful than traditional equations—as a more forgiving *Wired* review put it, "the algorithm is mightier than the equation." The distinction between equations and programs can be cast in historical terms. If Newton and Leibniz had invented the calculus in the nineteenth century and Babbage a usable digital computer in the seventeenth century, modern science might have taken a dramatically different course. The term "algorithm" dates as far back as the 800s in Muslim civilization and it captured the even earlier Hindu notion of reckoning in a series of steps. But since most scientific activity moved to Europe (even northern Europe) from Arabia and India after the Renaissance, the idea of the rule, and more particularly the equation, supplanted the older idea of reckoning in a series of steps as the principal mathematical approach to natural systems. In Protestant northern Europe, the word was deemed mightier than the image and we can take an equation to be a precisely defined word. As a result, as illustrated in Figure 1, Wolfram challenges us to do a transplant of the heart of modern science, replacing equations with programs. Hence the title, *A New Kind of Science*.

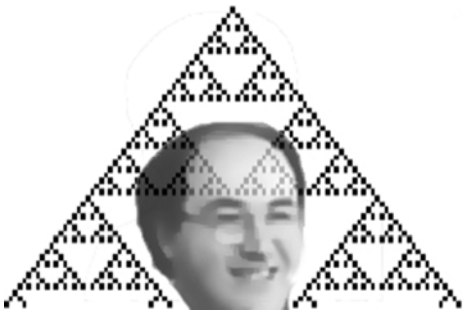

Figure 1: *Cellular Wolfram.* Nobody has studied cellular automata more carefully, no one has advocated their scientific utility more broadly, and no one has challenged scientific orthodoxy as radically as Wolfram. The CA run in the background is the notable Rule 30.

In fact, he believes that the universe is driven by a simple program, perhaps only a few lines long—mind-boggling since an operating system such as Windows is on the order of 50 million lines of code. To the question, "Have you discovered the simple program that is generating the universe?" Wolfram answers, "Not yet," but leaves little doubt he is hot on the trail. If he does, of course, Einstein and Newton will take much smaller places in the history of science than Wolfram. Almost 1300 pages repeatedly underscore the "discoveries" that Wolfram believes he has made. Many reviewers have complained about his insufferable self-promotion and the self-absorbed way in which *ANKS* makes few references to other work. The prose is simple, direct, repetitive and monumentally egocentric.

Moreover, *ANKS* evidences little regard for conventional academic argument. While there is copious evidence in *ANKS*, Wolfram is maddeningly resistant to the reasonable expectation that he should carefully argue his way to his conclusions. He curtly dismisses Darwinian natural selection (notably, not from theological qualms), for example, and suggests most misunderstand and misapply the Second Law of thermodynamics. Almost never anticipating an objection, he often tells us that he "strongly believes" this or that. He routinely expects the significance of his evidence to be obvious and the authority of his research to be beyond reproach. Perhaps because the writing is simple and remarkably accessible a disconcerting vagueness characterizes many pages. His critics, therefore, have many grounds for objecting to Wolfram's self-published "retail science."

The Crisis in Science and Computational Irreducibility

But even granting that the many criticism of *ANKS* have considerable merit, Wolfram is on to something that many critics miss. There is a crisis in contemporary science as documented by former *Scientific American* editor John Horgan and reinforced by the problem of underdetermination coming out of philosophy of science.[1] Wolfram provides additional evidence for the crisis as he builds a case for a reconceptualizing of science. He tries to convince us that most advances in modern science involved finding a shortcut that allows us to determine the outcome of a system's behavior without following each step of its evolution. But the rise first of chaos and then complexity studies suggests this approach has reached the point of diminishing returns. It is surprising, in fact, how little of what we experience can be explained scientifically (turbulence, the stock market, cascading power outages, Islamic fundamentalism, California politics, epilepsy, an eccentric uncle who lives in a pop-up trailer).

His discussion of image compression illustrates his point with untypical clarity. Any user of Photoshop preparing an image for the Web understands that the amount of satisfactory compression that can be achieved will principally be a function of the complexity of the image. The greater the complexity of the image, the less successful attempts to compress the image satisfactorily will be. One can optimistically stipulate a certain size, trusting in the powers of "advanced algorithms," only to witness a disappointing degradation of the image. We can view such degradation as a visual analogue of the failure of equations to capture fully the behavior of complex systems. Wolfram casts this problem in cognitive science terms by observing, "so in practice what we most often mean when we say that something seems complex is that the particular processes that are involved in human visual perception have failed to extract a short description." The more complex the image, in sum, the less computational and visual compression schemes will work.

But traditional science, in search of laws of nature expressible in mathematical equations, must suppose that complex systems are analogous to highly compressible images. Traditional mathematical approaches in science are useful, therefore, only when the behavior being analyzed is amenable to computational compression. Equations used in laws provide constraints but such equations are based on samples of complex behavior and no amount of sampling—short of the full detail of the complexity—will yield satisfactory results for complex systems such as a living cell. An attempt to do equation-based science of complex systems, therefore, embodies the same

[1] The best introduction to the problem of underdetermination remains Peter Kosso, An *Introduction to the Philosophy of Science* (Cambridge: Cambridge University Press, 1993).

misplaced optimism as the Photoshop user who specifies an aggressive compression of a complex image. The behavior of such complex systems, using compression schemes such as traditional equations, proves undecidable very quickly. Just as the complex image degrades under compression, the utility of equations for capturing complex-system behavior erodes.

Wolfram tacitly hinges much of the appeal of his heterodox science on the pivotal notion of *computational irreducibility*. Any traditional theory, he points out, that makes use of conventional equations, is predicated on shortcuts analogous to image compression. Traditional science has assumed that more complicated equations, based on more sophisticated models, could capture much or all of the behavior of complex systems; the optimistic Photoshop user holds out the hope of a better compression algorithm. Both hopes are predicated on the computational reducibility of the systems under study. But like complex images, complex systems are resistant to such compression; instead, our evidence so far is that they are computationally irreducible. The presence of this irreducibility means that much of the information about a complex system can be gotten only by doing an irreducibly large amount of computation. Since some of the information about the system is lost in the sampling, and the parts not sampled will inevitably be used in the evolution of a complex system, short-hand descriptions based on sampling won't do well. Since small bits of information are critical to understanding such behavior, we won't know enough about it to understand, predict, or control it by conventional means. Consequently, "whenever computational irreducibility is present it is inevitable that the traditional methods of theoretical science will not work." If this is right, computational irreducibility in the wide range of complex systems that we find in the world represents one of the most profound limitative results that science has had to face in its entire history. In fact, it fundamentally recasts the task of science.

Wolfram believes that the phenomenon of computational irreducibility, which characterizes all complex adaptive systems, explains why traditional science has fared so poorly in dealing with such systems. He christens his way out of this dilemma the "Principle of Computational Equivalence" (PCE). Wolfram has been widely criticized for equivocally defining this pivotal idea, but the following seems both accurate and intelligible:

(a) all the systems in nature follow simple rules
(b) most such systems that are not "obviously simple" are equivalent in their complexity—they are universal in the sense their program is capable of emulating any other universal system
(c) work and insight into the characteristics of any one system can help us improve our understanding of all other universal systems

Universality is the pivotal property of a system being able to perform all the computable tasks by simply changing its program; universal systems, no matter how different they appear, can only do computations of equivalent complexity. The reason that a compression algorithm cannot effectively compress a complex image is that the computational sophistication of the compression algorithm can be no greater than the algorithm that produced the complex image (since the image can be viewed as the product of a computation). Notably, universality entails computational irreducibility; where universality is present, the system is computationally irreducible.

Wolfram is not suggesting that horses can fly or that pigeons can run swiftly, nor is he suggesting that a person can compute the decimal expansion of π as fast as a supercomputer; the claim is that the computations requisite to all these tasks are at the same level of complexity.

More specifically, universal biological systems are no more computationally complex than universal non-biological systems. The commission this gives for computer simulation of natural phenomena as the now-preferred form of scientific practice should be obvious.

Figure 2: *Universality*. Wolfram claims that we can view the vast range of complex systems, from computers to horses to economies to brains, with their evident difference in detail and levels of sophistication, as computations of equivalent complexity. Indeed, there is an upper limit to the complexity of such computations that is lower than we might have thought. This opens perhaps science's last door to successful theorizing about such systems.

Wolfram's achievement, as he sees it, is that the PCE means that all the seemingly unrelated and dissimilar complexity that we see at every turn, that seems to represent an insuperable impediment to scientific progress, in fact turns out to be remarkably similar in the sense that the underlying programs are equivalent in sophistication. There are not varying levels of universality; instead, one size truly fits all. While others have imagined—he assures us—that universality must have complex origins, have lots of levels, and be comparatively rare, he has discovered that it is simply generated, has only one level, and is quite widespread. Reaching a much deeper understanding of the lineaments of such universality, as a result, is our ticket to whatever kind of theorizing we can do with these systems—conventional mathematics hasn't helped much and won't help much. Instead of many problems of varying sizes and degrees of complexity, Wolfram's conception reduces all this to one class of problems. Call the PCE, therefore, "Wolfram's Razor."

Wolfram believes that his unparalleled work with cellular automata, with his documentation that Rule 110 as well as others are universal, should reassure us that simple rules can give rise to universality. Universal systems can emulate each other, given the right change in program and perhaps initial state. What the PCE and its correlated doctrine of universality do, according to Wolfram, "is to assert that when viewed in computational terms there is a fundamental equivalence between many different kinds of processes." A human brain can compute no larger a class of computable functions than a computer, and this leaves open the possibility that we might usefully simulate a brain on a computer with the right model and the right software. The quest is reduced to finding the rule for one system (a brain) that we can emulate on another (a computer).

Assessing Wolfram's Heresy

How do we assess Wolfram's full-scale heterodoxy? In general, as we might expect given a heretical challenge to an institution as invested in orthodoxy as contemporary science, most responses to Wolfram have been critical or even caustic; if it took the Roman Catholic Church five hundred years to accept the Reformation doctrine of *sola gratia*, we should not be surprised that Wolfram's heterodox views have not been generally well received. Indeed, we have to concede that Wolfram has largely stipulated the Principle of Computational Equivalence. Proofs based on irreducible CA runs will be rare and underdetermination will preclude decisive

arguments; indeed, the developer of *Mathematica* has led the way in dismissing the continuing importance of mathematical proof. These factors partly explain his resort to stipulation. He rules out, as we saw, all the evident differences in complexity between the sundry complex adaptive systems that we observe. But is the behavior of the stock market on a politically turbulent day really computationally equivalent to Rule 30? How could we possibly know this? This is a kind of computational behaviorism since he insists that such varying systems can be "viewed" computationally from the outside. His use of the word "viewed" skates past numerous epistemological issues. Indeed, this means that he ignores what is perhaps the central achievement of post-Enlightenment philosophy, namely Kant's distinction between the noumenal and phenomenal realms. "What is it like to be a bat," to invoke Thomas Nagel's famous phrase, is irrelevant according to the PCE to making sense of a bat's behavior. In fact, as we will see, he is not consistent since he will back away from the PCE when it comes to "what it is like to be a human."

For all the shortcomings of *A New Kind of Science*, however, what many critics miss is that Wolfram's approach to science may be the only one that will sustain the classic scientific hope that much can be explained theoretically and mathematically. If he is a Luther, he wants to repair, not destroy, the ecclesia. While our understanding of what kind of mathematics is pertinent to a science of complex systems will change markedly on Wolfram's view, *ANKS* tries to sustain the conventional hope that complexity can be more than one more set of limitative constraints on traditional science—that complexity can become a theoretical enterprise. Wolfram maintains that there is much greater similarity between all kinds of seemingly disparate systems than most traditional science understands and that this similarity should revive the prospects for significant theoretical (computationally reducible) understanding of some parts of complex systems. He holds out the hope that there can be a genuine complexity theory that explains much.

While a compelling articulation of Wolfram's insight has yet to be made, unless he is at least largely right, then there can be no integrated, theoretically significant approach to complex systems. As Weinberg observes of complexity studies, "all this work has not come together in a general theory of complexity."[2] Unless a view something like Wolfram's is the case—that driving all the myriad complexity we see is remarkably simple rules—it is unlikely we will ever have a general theory of complex systems. Complexity studies will have to be content with description, patchwork, low-level theorizing, and, finally, narrative. Instead of all historians being scientists, as Carl Hempel of Princeton had hoped in the last century, all scientists working with anything other than simple systems will turn out to be historians.

Some complexity proponents are content to advocate a patchwork of insights and low-level theories, augmented by description and narrative, but Wolfram is clearly not among these meek practitioners. Classical reductionists, who are often physicists, hold on to the old reductionist dream that all can be explained by simple, basic laws or principles. Wolfram, the former physicist, is a kind of reductionist, since he believes there is a simple rule at the base of the universe, but he is also an emergentist since he thinks this rule is a program whose behavior is often irreducible. In other words, even as a complexity proponent, in his heart of hearts he is a classical reductionist. I believe he is gallantly trying to save science as a theoretical enterprise and most critics fail to grasp the size of the challenge or provide an alternative approach that does better than conventional mathematics.

Surprising as it might appear, Wolfram's Rule 30 (the one behind his head in Figure 1), a small program running on his desktop computer in his house outside Chicago, therefore puta-

[2] http:://www.nybooks.com/articles/15762.

tively becomes a window onto a new way of doing science that claims to get us out of the current morass. The swirl of controversy surrounding the publication of *ANKS* notwithstanding, we need to get past the inconsequential issues (such as Wolfram's irritating presumption) to the real question of whether he might be at least partly right. One can have a novel or essential insight even while arguing it badly; that a writer argues a claim badly does not mean the claim is useless. This is the question that the scientific community must distill in the wake of the publication of *ANKS*.

A final twist completes this section. At the end of *ANKS*, Wolfram discusses history, social science and what makes us distinctly human. One might imagine that Wolfram's computational behaviorism and his stipulated PCE has left him sanguine with regard to grasping history and doing some social science. Remarkably, however, he concedes that "abstract descriptions" of the kind he advocates with the PCE "will never ultimately distinguish us from all sorts of other systems in nature and elsewhere." One might imagine that this simply entails traditional materialism, reductionism and a dismissal of human uniqueness. But this is not the case:

> And what this means is that in a sense there can be no abstract basic science of the human condition—only something that involves all sorts of specific details of humans and their history. So while we might have imagined that science would eventually show us how to rise above all our human details what we now see is that in fact these details are in effect the only important thing about us.

Does this not undercut any attempt to give theoretical accounts of complex systems involving human beings? "These details are … the only important thing about us." If humanity is created *imago dei*, as Judeo-Christian thought maintains, by Wolfram's additional lights, humanity must "viewed" as an incompressible image. With friends like Wolfram, the social sciences need no enemies.

II. Radical Orthodoxy in Christian Theology

Radical Orthodoxy (RO) began some years ago among a group of Cambridge theologians led by John Milbank, an Anglican, but soon generated wider interest among Roman Catholics and even evangelicals. It is orthodox in the sense of espousing traditionalist Christian doctrine but radical in its claim that much of Christian theology since the time of Duns Scotus has deferred too readily to the rise of other disciplines and a secularity that dismisses the centrality of revelation for making sense of the world. For RO, the contemporary academic scene is a proverbial Tower of Babel that conventional theology has acquiesced in building.

Radical Orthodoxy, it must be said, would object to this essay if it consists of the argument that there is some development in science that would help us reframe theology. It would object to the idea, more specifically, that there are implications coming out of Wolfram's challenge to science that would *aid* theology. This is so because RO rejects any suggestion that theology should be assessed or reworked or modified because some new development has come along in "secular" disciplines. Indeed, for RO, it is not theology which has hat in hand in front of the tribunal of the secular disciplines; it is the other way about.

Modernism, the Enlightenment, and Analytical Philosophy

Twentieth-century modernism, inspired most of all by the Enlightenment, is in its death throes for RO. RO sees most of twentieth-century and later theology as allied with the assumptions of the Enlightenment in such a way that theology inexorably is relegated to the sidelines when it should be the fundamental discipline which grounds all others. Modernism assumed, among other things, that an exact picture of the material world is possible, at least in principle. Indeed, that was the goal of nineteenth-century Newtonian physics just prior to the discovery of x-rays. The advent of quantum mechanics, of course, derailed the classical quest for an exact picture. In fact, it was rendered incoherent.

What specificially is it about the Enlightenment that generates such resistance for Radical Orthodoxy? If "man is the measure of all things" was the shibboleth for the Renaissance, "individual human reason is the arbiter of all claims" is a good way to characterize the Enlightenment, especially in its more aggressive expressions in the work of Hume and Spinoza. *Sola ratio* would be the more radical Enlightenment's analogue to the Reformation's *sola gratia*.

Radical Orthodoxy specifically singles out analytical philosophy for theological censure. Analytic philosophy enthusiastically carries the Enlightenment torch perhaps more than any other contemporary discipline. The sciences and mathematics have been stymied by various limitative results including quantum mechanics, Gödel incompleteness and, of course, complexity studies. Humanities such as English and political science have become self-absorbed in various deconstructionist antinomies. Analytic philosophy, notably expressed in the work of such rationalists as Bertrand Russell and David Lewis, has singularly kept the Enlightenment faith alive despite the contrapuntal work of naturalists such as Philip Kitcher and Ron Giere.

Neither Wittgenstein nor Rorty play large roles in RO's criticisms of analytic philosophy, but they should. The later Wittgenstein argued that there cannot be a private language used in isolation from a community, which contradicts the individualist epistemology characterizing analytic philosophy all the way back to Descartes. The meaning of language, on the view of the later Wittgenstein, cannot be private or based on its relation to facts in the world, but must be rooted in community usage. RO is disposed to second this view even if it has said less about Wittgenstein than the French deconstructionists.

Rorty is perhaps the most controversial of contemporary philosophers and his work is pivotal to understanding the controversies generated by RO. Rorty was trained as an analytic philosopher but has appropriated Continental thought to underscore the claim that there is no objective structure of mind which can be a foundation for our attempts to understand the world. There is no objective philosophical stance from which the philosopher can claim to work. If this is right, then philosophy has no privileged position to arbitrate the soundness of the theological claims derived from revelation and theology need no longer defer to philosophy as the policeman of the canons of rationality.

The Death Secular Consensus and the Problem of Underdetermination

RO argues that what might be called the "secular consensus" is also dying. As Jeff Sharlett has commented, "the logic of secularism" is dissolving. It is difficult tooverestimate the importance of logic for philosophy in particular and the academy more generally over the last 130 years. Frege and Russell not only inaugurated the modern analytic age but helped pave the way for the advent of inexpensive computing which revolutionized much of the academy. But

increasingly, it is doubtful that logic can be as helpful as those pioneers once imagined. We are less inclined to insist that the world obey our logical maxims and, since the advent of quantum mechanics, we have been more willing to sacrifice our logical maxims for the sake of empirical adequacy to how the world appears to behave. The question, "But is that logical?" has less force than it would have had in 1900.

Strikingly, unlike modernist theological movements that defer the truth of the natural sphere to the secular sciences, RO argues that no aspect of human existence or creation can be understood aside from revelation. Indeed, it does not recognize the independence of other disciplines from theology, whether those disciplines be philosophy, physics or sociology. More trenchantly still, RO sees in the modern academy a deeply flawed, deficient experiment that is imploding on itself. "The end of modernity," John Millbank has argued, "which is not accomplished, yet continues to arrive, means the end of a single system of truth based on universal reason, which tells us what reality is like."[3]

The limitative result called "underdetermination" comes out of several decades of work in philosophy of science and it claims that logic and evidence (the best logic and any amount of evidence) are unable to pick out true theories from candidates for "truth." The great hope of empiricism in the twentieth century has now died even though the funeral arrangements are still pending. It follows that talk of "*the* scientific method" is unhelpful and naïve. Indeed, to the extent that there is a method—a logical form—to science, it is demonstrably and embarrassingly *in*valid.[4]

As a result, RO argues that post-modernism has successfully derailed the philosophical and cultural consensus that provided a foundation for modernism. Foundation talk, there is now considerable agreement, is irremediably quaint.

The Death of Post-modernism and a Participatory Ontology

Post-modernism itself turns out to be a self-destructive movement. While post-modernism has celebrated its overturn of the foundations of modernism, according to the proponents of Radical Orthodoxy, its work also makes impossible any foundations for its own program of research. There is no foundation either for modernism or post-modernism.

RO's epistemology is predicated on *participation* as the only acceptable metaphysical model for understanding the world as creation. Since the time of Scotus, much academic work has been disposed to view the world in such a way that theology is relegated to an antiquated sideshow. RO objects strenuously that theology in a variety of confessional traditions has too often meekly acquiesced to this usurpation. Postmodern ontology, according to RO, is characterized by a materialism—a speciously egalitarian "flatness" in which every being in the world is equally significant—that inexorably leads to nihilism. In a post-Augustinian metaphysics in which there is no longer a suspension from the Creator, all is immanent and therefore insignificant and even absurd (Sartre gives a good analysis of this). Only a participatory, Augustinian and neo-Platonist ontology—in which the immanent and material is *created by* and *dependent on* the transcendent and immaterial—can generate the meaning that currently eludes secular research in the sundry disciplines.

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[3] Ward, Graham, *The Postmodern God* (Oxford: Blackwell), p. 265.

[4] The logical form of the simple confirmationist view of scientific method is 'T-> O, O, therefore T', which, of course, constitutes the fallacy of affirming the consequent.

Notably, on this view, all disciplines must derive from a theological perspective; if defined alternately, as self-sufficient inquiries, such disciplines will define a domain separate from God, and will therefore be grounded in nothing. RO calls for a complete Christian reassessment and transformation of the "secular" disciplines so that they are grounded epistemologically in terms of revelation. The disciplines have meaning only insofar as they are predicated ontologically in terms of *participation*. Every sphere of creation—by definition for RO—participates in the fundamental gift of the Creator. Every dimension of the world must therefore be investigated as *created*.

Language and Communities

Last, RO argues that all that remains of our sundry attempts to make sense of the world is language expressed in communities. Indeed, the logos of God is the only certainty that can withstand the long list of limitative results from the twentieth century. More specifically, Pickstock argues that the Western philosophical tradition itself lives within the liturgy of the church and the liturgy, in fact, is the only context in which the philosophical tradition can generate meaningful discourse. The axis of the liturgy, of course, is the Eucharist and the apotheosis of the Eucharist, for Pickstock, enamored as she is of the pre-Vatican II, Roman Rite, is ringing of the sanctus bell at the moment of transubstantiation.

> Paradoxically, the event of transubstantiation, in which the bread and wine are seemingly reduced to accidents, is precisely the moment when we can be absolutely assured of the *material truth* of bread and wine, precisely because they entirely convey the reality of the divine body. Where we register that the material has become totally suffused by God, there alone we can be sure of material reality, and thus of the meaningfulness of our words which, as Aquinas asserted, always first of all denote the sensorily registered.[5]

Notably, all human attempts at knowledge and understanding must be rooted in theology. Where there is no participation in divine disclosure there is no meaning. Theology itself takes its meaning to the extent that it is based on revelation in Scripture and church tradition and grounded experientially on the Eucharistic liturgy.

While some Catholic critics have faulted RO's inadequate ecclesiology, RO's striking emphasis on what might be labeled its Eucharistic epistemology provides at least a start towards a potent ecclesiology; we should remember that the movement is not fully mature. The Eucharist presupposes a Eucharistic community and only in community can transubstantiation do its foundational work. The gathered assembly does not just provide for the cure of souls, therefore, it provides for the cure of the nihilistic academy as well.

III. Algorithm in Science and Religion: Recasting the Dialogue

Wolfram evidently has little interest in Christian theology and I would be surprised if RO theologians are very interested in the Principle of Computational Equivalence or esoterica such as cellular automata. Indeed, these two areas of contemporary research seem worlds and sensi-

[5] (http://www.secondspring.co.uk/archive/scaldecott24.htm).

bilities apart. Yet, there are some parallels that I believe can help us recast the science-and-religion dialogue. Recall Wolfram's emphasis on program and computational irreducibility and RO's emphasis on liturgy and what I called "Eucharistic epistemology." Pickstock criticizes post-Vatican II Roman liturgy because it largely eliminates the seemingly repetitive classical Roman rite. Pickstock is saying that there is an irreducibility to the Roman rite that modern liturgical reform fails to understand.

"Irreducibility" does not carry the same connotations, of course, when used in different contexts by different communities. But understood analogously in the seemingly different contexts of scientific simulation and liturgical expression, it might help us see past what I take to be unnecessarily confrontational views of science and religion. If, in fact, we become more impressed that varying kinds of irreducibility characterize much more than we had previously imagined, the materialism and reductionism that were typical of much twentieth-century science can be correctly identified as a tendentious excess. Complexity studies, including the work by Wolfram, have made a strong case that the most interesting phenomena will not be captured by Enlightenment law-of-nature talk that strives to reduce phenomena to constituent parts. Naïve realists might hold out the fading hope that science will still be able to understand, predict and control phenomena, but naïve realism has come on hard times in contemporary philosophy of science; religion need no longer joust with a view of science that guarantees confrontation.

Simulation has become the "third form of science" after theory and experiment. The many dimensions and universes of contemporary physical theory make the speculations of the most aggressive natural theologians seem tame by comparison. Only time will tell whether Wolfram's heterodox claims will revolutionize science. But it seems clear now that there is no going back to the science of yesteryear with its seeming espousal of laws of nature that preclude phenomena such as the miraculous that Christianity in particular embraces.[6] There are no considerations coming out of more recent science that will preclude a distinguished string theorist from relishing the ringing of the sanctus bells during the Eucharist.

But views of science are often like iron-ore boats entering the harbor at Duluth, Minnesota. They are long and heavy and run on for miles without forceful intervention. Thus it is no surprise that volumes such as Paul Kurtz's *Science and Religion: Are They Compatible?* still appear.[7] Most of the essays in this volume presuppose a traditional, confirmationist understanding of science that philosophy of science largely abandoned some time ago. While Kurtz is measured in his arguments, his claim that science achieves "reliable knowledge in discipline after discipline" makes it sound as though we are closing in on that nineteenth-century aspiration for a science which has understood and explained most phenomena. But while twentieth-century popular imagination supposed we have mastered the atom, it is not clear that we have. The range of our understanding remains remarkably modest; infectious diseases and international economies remain vexingly beyond our command. The generally pejorative view of religion reflected in most of the volume's essays come not from science *per se* but from personal or social bias; the bits, we learn in computer science, never supply their own interpretation and neither does scientific data.

Wolfram's challenge means that we cannot uncritically suppose that there is just one view of science as having discovered the truth about the "material world." Giere reminds us that a

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[6] John Earman's *Hume's Abject Failure* (Oxford, 2000) shows why we have uncritically accepted Hume's specious argument against miracles for two hundred fifty years.
[7] Amherst: Prometheus Books, 2003.

more temperate view of science thinks in terms of models rather than laws. [8] Despite some recent breakthroughs in prime number theory that may have a range of productive application in seemingly disparate domains, we are farther from the nineteenth-century dream of discovering the fundamental laws of the universe than they were. Wolfram reminds us that we often must be content to describe rather than explain complex adaptive systems that must be allowed to run. The era of "empirical mathematics" is here. There is an irreducibility to such systems that equations, the preponderance of the available evidence suggestions, will not be able to resolve.

But there is a drama as well. Irreducibility courses through the universe in ways that surprise both the traditional mathematician and conventional physical theorist. Anomalous data continue to excite and distress those interested in explanation. We have a general picture of the origins of the universe but we cannot, I believe, claim that we have a reductionist-style explanation. Unification eludes us just as it did Einstein. We advance a step or two here or there, only to discover that we have been pushed back three. Theory may prove to have less value than Enlightenment-based science imagined. We may have to rest content to take recourse in narrative rather than theory for the most interesting phenomena we witness. Story and drama go together since any good story will have elements of drama.

Liturgy is dramatic narrative. There is movement even as there is repetition. Theology has too often cast its lot with theory, RO would point out, when narrative is the more inclusive category in a universe that seems to be telling us a story. Process theology, for example, based on Whiteheadean theory, increasingly seems as stale as nineteenth-century gradualism in both geology and biology because *process* language presupposes antediluvian notions of reducibility. Wolfram is telling us that a simulation has to be run to see how it will behave. No characterization of its rules will allow us to reduce it to an equation. History is more important than logic. Liturgy must be experienced, lived and embraced for it to do the work that Radical Orthodoxy claims is requisite to meaning in human discourse. Wolfram would understand the intuition even if he did not subscribe to the claim. RO, in watching Wolfram's CA runs, would agree to some of the insights even it did not share his recalcitrant materialism.

By the lights I find illuminating, RO dismisses the achievements of analytical philosophy precipitously. RO can rapidly deteriorate into dogmatism without the sterling insight of analytic philosophy: careful arguments are to be preferred to assertions and unsupported appeals to authority if we are to make better sense of the world. Yet, RO correctly reminds us that there is a crisis haunting the land. We have attempted to build our academic castles on shifting sands. The cacophony that is the modern academy suggests that RO's claims warrant a hearing. Similarly, Wolfram's critique of conventional science constitutes an additional nail in the coffin of a naïve realism that still shapes too many science-and-religion conversations.

Wolfram's work and the insights of RO suggest that it is time to reframe the dialogue between science and religion. Neither has carried the day and both have many questions to answer. But the parallel insight that irreducibility characterizes the most interesting phenomena and that we must use step-by-step models and liturgical forms to create models in science and meaning in human communities offers a fresh chance to recast science's relationship to Christianity in particular and religion in general.

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[8] *Science Without Laws* (Chicago: University of Chicago Press, 1999).