LOCATING THE BOUNDARY

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ALTHOUGH THE ENTIRE PHYSICAL UNIVERSE MAY BE the *object* of investigation by the natural sciences, not all of its attributes fall within the *domain* of scientific inquiry. But before we approach this matter formally, let's illustrate the distinction between object and domain with an example that is close at hand.

The words that appear on this page are formed by a particular distribution of ink on paper. Employing all of the tools of natural science we may be able to determine the identity and (within certain limits) the location of every atom comprising this printed page. But this scientific description of the spatial distribution of atoms would be notably incomplete. It would, no matter how complete from the standpoint of natural science, still fail to reveal an authentic and important

feature of this page—the fact that this particular distribution of atoms and molecules forms words, and that these words convey a certain message.

Natural science is an appropriate and powerful tool for investigating and gaining knowledge about the physical features of the object of its study, but is wholly incapable of discovering its *meaning.* Consequently, to say that this page is nothing but a particular assembly of atoms and molecules, or to assert that the physical universe is "all there is or ever was or ever will be" is to speak nonsense.[1] Donald MacKay, in *The Clockwork Image,* calls this nonsense by the colorful but appropriate name "nothing buttery."[2]

Furthermore, to assert that natural science is capable of answering all meaningful questions about reality or that only those questions answerable by natural science are truly meaningful is also nonsense. Such outlandish assertions are not claims made by natural science itself; they are the philosophical-religious assertions of what is better known as *scientism.* To have a healthy respect for what we can learn by studying the world of atoms and molecules is good science, but to claim that natural science is the only path to knowledge or that it is applicable to everything is an arrogant expression of scientism. The distinction between science and scientism ought never to be overlooked.

The Questions Natural Science Addresses

Speaking more formally now, to identify the *domain* of natural science is to identify the categories of questions that it is capable of addressing. As our example of the printed page has illustrated, the natural sciences are not capable of dealing with all conceivable questions about a physical object; only certain categories of questions lie within its domain. We shall approach the matter of identifying the boundary of this domain by citing several additional examples of questions that clearly lie within the scientific domain and then noting the categories into which these questions naturally fit. We will, of course, keep in

mind that these must all be questions about the proper object of scientific investigation—the physical universe and its constituent parts.

What is the surface temperature of the star Betelgeuse? What is the value of the proton mass? What is the structure of a DNA molecule? All of these are appropriate questions for scientific investigation. Each of them fits into the category of questions concerning the *physical properties* of physical objects. All questions that fit into this category, we believe, lie within the domain of natural science.

Consider another family of questions: What physical process is responsible for maintaining the surface temperature of Betelgeuse? What takes place when an acid and a base are combined? What occurs in the process of photosynthesis? These, too, are questions that the natural sciences are capable of investigating. Each of these questions fits squarely within the general category of questions concerning the *physical behavior* of some physical system, and, as such, it lies within the domain of natural science. As a matter of fact, one of the major endeavors in natural science is to construct adequate and accurate descriptions of such phenomena and to discover the universally applicable patterns of physical behavior exhibited by systems with like properties.

Finally, a third family of related questions: What sequence of events and processes has contributed to the formation of the Grand Canyon? What occurred on the surface of the moon to form the craters and other features visible to us? What is the history of life forms on earth? Does the visible universe of dispersing galaxies have a discernible history? If so, what is the character and chronology of that history?

While these questions may seem somewhat more difficult than most of those cited earlier, these too are examples of questions that are open to investigation by the natural sciences. Questions like these fall into the broad category of questions concerning the *formative history* of the earth and its inhabitants, of other bodies in the solar system, and of the entire observable universe. On the basis of what has been

discovered during the past century or two, we judge that these fascinating questions concerning the formative history of physical systems, including living systems, also lie within the domain of the natural sciences and are fruitful questions that merit careful scientific investigation.[3]

At the risk of oversimplification, we shall say that all (or certainly the vast majority) of the questions that lie within the domain of natural science can be comfortably placed within one of the three categories just introduced: the categories of *physical properties, physical behavior* and *formative history.*[4] Furthermore, we find it helpful to note that these three categories may be viewed as subdivisions of a larger category of classification: the *inherent intelligibility* of the physical universe. But that very formal term requires further clarification.

By experience and reflection, the human race has come to view the physical world as intelligible, that is, capable of being understood at least in part. The physical universe exhibits properties that are stable and measurable. And when we observe the behavior of physical systems, we discover universally applicable patterns of physical behavior. We are able to make sense out of individual phenomena because they fit into larger patterns—patterns which are empirically accessible and discernible by human investigators.

Furthermore, because the values of physical properties and the patterns of physical behavior are stable, we are able to recognize numerous features of the world around us as the products or consequences of earlier events and processes. We have discovered that even the formative history of the physical universe is intelligible.

But why do we add the qualifier *inherent* when we say that the domain of natural science is limited to the inherent intelligibility of the physical universe? The answer can be stated very straightforwardly. In essence, we must include the qualifier *inherent* because the physical universe—the object of investigation by the natural sciences—is *not* all there is. There is more to reality than the physical alone.

Along with the physical world, for example, there exist the "worlds" of abstract ideas and transcendent beings, of profound concepts such as beauty and truth, of human emotions such as love and fear, of moral principles for good and right, and of spiritual beings and their actions. As whole persons, scientists may employ elements from these nonmaterial "worlds" in their personal efforts to understand the meaning of the physical universe, but such elements are not themselves the object of natural science.

As an intellectual discipline, natural science is not isolated from or unrelated to human concerns for all that transcends the realm of physical phenomena, but nevertheless it self-consciously restricts itself to the physical universe as the object of its study. Natural science is the investigation of what can be known from within the physical world itself, without reference to anything that is nonphysical. It seeks to know the character of the component parts of the physical universe and their relationship to one another, but it sets aside the matter of the relationship of the physical world to any beings or realms of reality that transcend the physical world.

Questions concerning transcendent relationships lie outside of the domain of natural science. Science is unable, for example, to say anything about the relationship of the world to a divine Creator. Questions concerning the relationship of the universe to God must be directed elsewhere. The silence of natural science on such matters must be honored by both theists and nontheists. Both must resist the temptation to coerce science into warranting (in the sense of proving) their particular religious perspective.

Science is well equipped to deal with scientific questions regarding the inherent intelligibility of the physical world, and religion is well equipped to deal with the religious question of the relationship of this universe to a transcendent deity. Natural science and religion each deserve to have their unique domains respected by the other. Only when the integrity of each domain is respected can questions concerning their relationship and interaction be fruitfully explored.

Questions Lying outside the Domain of Natural Science

Because of the importance of this distinction between the domains of inherent intelligibility and transcendent relationship, let us cite a couple of examples of matters on which the natural sciences, because of their limited domain, must maintain respectful silence.

1. While natural science can fruitfully investigate the formation *of various structures within the physical world, it is incapable of dealing with the ultimate* origin *of the world's existence.*

Because of a great deal of misunderstanding concerning the word *origin,* this statement must be clarified. Very often, the word *origin* is used as a substitute for the word *formation.* When geologists, for example, speak of the origin of the Grand Canyon they are concerned with the succession of events and processes that make up the formative history of this magnificent geological structure. The uplift of continental land masses and the process of fluid erosion are examples of phenomena relevant to canyon formation.

Similarly, when astronomers speak about the origin and evolution of planets or stars or galaxies, their concern is with the processes by which these celestial objects developed their present form from earlier structures. Even when cosmologists speak about the origin of the entire expanding universe, they speak in terms of those processes by which the present state of affairs developed from earlier states. In the context of purely scientific inquiry, a discussion of origins must necessarily be restricted to a consideration of the *formation* of physical structures within the universe, the existence of which is taken for granted.

The question of ultimate *origin,* however, goes far beyond the matter of formative history. When we ask, What is the ultimate origin of the universe? we are asking, What is the source for the very existence of the universe? What agent causes *something* to exist in place of *nothing?* Furthermore, we are asking not merely about the *beginning* of existence, but about the existence of the universe at all times—past, present and future—even about the existence of time itself. The question concerning the source, or cause, or *origin,* of existence is just as much a question about right now as it is about any other moment in time.

This question of ultimate origin, however, lies well outside of the domain of natural science. We are able scientifically to deal with many kinds of events that happen in time, but we are unable to deal in the same way with questions concerning the source of time's very existence. We are not saying that the question concerning the origin of the universe cannot be asked; we are only saying that any consideration of its answer takes us beyond the domain of natural science and into the domain of philosophy (metaphysics) or religion.

A diversity of answers has been offered. According to philosophical naturalism, for example, the universe is self-originating, that is, its existence is independent of any nonphysical creative agent. In Christian theology, on the other hand, the origin of the world's existence is dependent at all times on the active will of God, the Creator—just as dependent at this moment as at any other moment, even the "beginning" of time.

Questions of *origin*—the ultimate source of existence itself—are profoundly important questions. Their answers, however, will never be derived from the results of natural science. They are religious questions that must be directed to whatever serves as the source of one's answers to religious questions. The natural sciences, because of limitations in both the object and the domain of their investigation, have no choice but to remain silent.

2. While natural science can fruitfully investigate the behavior *of the physical universe, it is incapable of settling the fundamental question concerning its* governance.

Just as *formation* and *origin* must be distinguished, so also *behavior* and *governance* must be distinguished—particularly in discussions concerning the relationship between science and religion. And, in a manner similar to our first distinction, we shall find one concept—*behavior*—to lie within the scientific domain and the other—*gover-*

nance—to lie outside of its boundary.

When natural scientists investigate the behavior of a physical system, they are concerned principally with the empirically accessible physical processes that take place within that system or with physical interactions between that system and its environment. Geologists, for example, are concerned with the behavior of the earth's crust in response to processes occurring within the earth itself and in response to earth's interactions with the sun and the moon. Chemists are concerned with the structure of atoms and with interactions among various atoms and molecules in a diversity of environmental conditions. Physicists seek to understand the behavior of physical systems and their interactions in terms of fundamental forces related to the physical properties of matter. And biologists endeavor to understand the physical behavior of living systems in terms of the structure and behavior of the cell and its constituent parts and in terms of the interaction of an organism with its environment. In each case, natural scientists are concerned to describe the observable behavior of some physical system and to discover the general patterns of behavior into which any specific phenomenon can be placed.

The search for a comprehensive set of interrelated patterns is the heart of the scientific enterprise. Our descriptions of these universal patterns of physical behavior are known by various generic titles: *scientific theories* or *theoretical models* or *laws of nature,* for instance. Specific examples include the special theory of relativity, the kinetic-molecular model for gases and the law of energy conservation. (We make no hard and fast distinction among the terms *theory, model* and *law;* these terms are nearly interchangeable, and the association of any one of them with a particular concept is more a matter of historical accident than of rigorous classification.)

To illustrate the behavior-governance distinction, let's take the law of energy conservation as an example. According to this "law," all physical systems behave in such a way that the total amount of energy possessed by the system and its environment remains constant.

Energy, we say, is always conserved; it can be neither created nor destroyed—only changed in form or transferred from one system to another. The law of energy conservation is a remarkably useful statement describing a very important aspect of the behavior of physical systems. Natural science, by empirically investigating the behavior of a wide variety of physical systems, has discovered a certain regular pattern to physical behavior and has formulated the law of energy conservation to describe that behavior pattern.

But why does the physical world behave in accordance with that pattern, or any other pattern? What power or agent *governs* physical behavior in a manner described by the energy conservation law? People sometimes speak as if the law itself governs that behavior; those introductory textbook discussions cited earlier are notorious for their talk about the "laws of nature that govern the behavior of physical systems."

Such talk, however is quite empty. The "laws of nature" are only our descriptions of the patterns of material behavior, and descriptions have no power to govern. The question of governance cannot be answered by describing patterns of behavior. Behavior patterns give evidence of a governing power at work, but such patterns are not themselves the source of governance. Behavior patterns are not the *cause* of governance; they are only the *result.*

Like the question of origin, the question of governance is fundamentally a religious question. Let's try to illustrate that by noting the difference between the answers provided by two very different religious perspectives that are prominent in Western culture: philosophical naturalism (or materialism), and Christian theism. According to naturalism, there exist no transcendent beings; the physical world is all there is. The governance of material behavior must be performed by matter itself. Matter, according to naturalism, is self-governing—autonomous.

Judeo-Christian theism, on the other hand, identifies God as the Governor of physical behavior. What we customarily call the "laws of

nature" are really our descriptions of the patterns of divine governance. These are not laws *of* nature for its self-governance, but rather they are the intelligible manifestations of God's will *for* the behavior of the created world. Physical behavior, according to theism, is not autonomous (self-governed), but theonomous (God-governed).

In the light of this behavior-governance distinction, it should be evident that the proponents of naturalism and of theism need have no disagreements concerning the proper description for the patterns of physical behavior. Provided that they do their scientific work in conformity with the accepted standards for competence and integrity and in the context of the community of professional natural scientists, persons with vastly differing religious commitments can and do work together toward the common goal of understanding the behavior of the physical universe—the object of scientific investigation.

However, while theists and philosophical naturalists need not disagree on matters of physical *behavior,* they are in profound disagreement on the matter of *governance.* But the choice between an autonomous or a theonomous perspective on the governance of physical behavior cannot be settled on the basis of scientific investigation. The proponents of these two differing religious perspectives need not work toward the development of different and competing scientific descriptions of behavior, even though they seek to understand the governance of that behavior within the frameworks of very different religious perspectives. From the one perspective, matter is both self-existent and self-governing; from the other, God is the ultimate reality and the physical world is dependent on God for both its existence (origin) and its governance.

Maintaining Proper Boundaries

Locating the boundary of the domain of natural science is of crucial concern to those of us who wish to establish and maintain an amicable working relationship between science and religion. The approach taken in this book is based on the recognition that while the

object of investigation by the natural sciences is the entire observable physical universe and its constituent parts—every physical thing that is empirically accessible—the *domain* of scientific inquiry is restricted to the inherent intelligibility of this universe. Working within this domain, natural scientists are capable of investigating the remarkable degree of intelligibility that is resident within the physical universe itself—in its physical properties, in its patterns of physical behavior and in its formative history.

On the other hand, questions concerning the relationship of the physical universe to any transcendent realm lie outside of the scientific domain. Such profound questions lie within the domain of religious or philosophical (metaphysical) inquiry. Consequently, while natural science can deal fruitfully with the formative history of the universe, questions concerning the origin, or source, of its existence must be directed elsewhere.

Similarly, while questions concerning physical behavior are appropriate questions for scientific inquiry, the question concerning the identity of the governing agent must be recognized as a religious question. Questions of origin and governance—important questions both—must be directed toward whatever serves as the source of answers to one's religious questions. And while the public-school classroom may be an appropriate place to raise these questions and to identify their religious significance, each student must seek answers within the context of his or her home community. On such matters the natural sciences have nothing to contribute.

physical universe. Even self-creating universes, it seems, must begin with some form of "self.") Once again, *The Creation* reveals its folk-science identity.

3. Is the distinction between behavior *and* governance *made clear?* In the absence of a clear delineation of the difference between the scientific description of a thing's *behavior* and the identification of the source of the *governance* of that behavior, natural science is likely to be perceived as if it were a competitor to any theistic perspective. The concept of the "natural" behavior of a physical system would then function as a rival to the concept of divine governance.

In the folk-science literature of evolutionary naturalism, for example, the functioning assumption is that if there is a scientific description (or theory) of the processes involved in the formation of species, then there is no room for a theistic concept of the divine governance of those processes. Readers are led, sometimes openly, sometimes surreptitiously, to adopt an either-or stance: The phenomena that comprise cosmic formation happen *either* as "natural" processes (scientifically describable) *or* as consequences of divine action. Once this "either-or-manship" is in place, then even a scientifically informed reconstruction of the formative history of the universe functions as naturalistic folk science, reassuring all of those persons who wish to believe that the scientific concept of evolution provides warrant for their naturalistic interpretation of physical phenomena.

We hope that the case studies and other discussions in this volume will be helpful in clarifying the character of natural science as presently practiced, and in distinguishing it from two particular strains of folk science that function in contemporary culture. Science, folk science and religion each occupy a legitimate place in the human enterprise, but great mischief is done when their differences go unrecognized. Surely the resurgent creation-evolution debate provides ample evidence for that.

Notes

Introduction: Charting the Course

[1]The historically fruitful partnership of natural science and the Christian faith has been documented by numerous writers. Highly readable accounts can be found in the following recent publications: Charles E. Hummel, *The Galileo Connection: Resolving Conflicts between Science & the Bible* (Downers Grove, Ill.: InterVarsity Press, 1986); David N. Livingstone, *Darwin's Forgotten Defenders: The Encounter between Evangelical Theology and Evolutionary Thought* (Grand Rapids: Eerdmans, 1987); and Colin A. Russell, *Crosscurrents: Interactions between Science & Faith* (Grand Rapids: Eerdmans, 1985).

Chapter 1: Locating the Boundary

[1]See Carl Sagan, *Cosmos* (New York: Random House, 1980), p. 4.

[2]Donald M. Mackay, *The Clockwork Image* (Downers Grove, Ill.: InterVarsity Press, 1974).

[3]If the reader is not well acquainted with the application of the natural sciences to the study of formative history, it may be helpful to consult an introductory textbook in earth science, or geology, or astronomy. Such textbooks ordinarily include a discussion of the ways in which the formative history of the earth or of stars is scientifically investigated.

[4]A similar delineation of the domain of natural science can be found in Howard J.

Van Till, *The Fourth Day: What the Bible and the Heavens Are Telling Us about the Creation* (Grand Rapids: Eerdmans, 1986), especially chapters six and ten.

Chapter 2: The Path Most Traveled

[1]See, for example, the following: Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2d ed. (Chicago: University of Chicago Press, 1970), and *The Essential Tension* (Chicago: University of Chicago Press, 1977), especially chapter thirteen, "Objectivity, Value Judgment, and Theory Choice," pp. 320-39; Larry Laudan, *Science and Values* (Berkeley: University of California Press, 1984); Ernan McMullin, "Values in Science," *PSA 1982* [Proceedings of the 1982 biennial meeting of the Philosophy of Science Association] (E. Lansing, Mich.: Philosophy of Science Association, 1983), Vol. 2; and Jerome R. Ravetz, *Scientific Knowledge and Its Social Problems* (New York: Oxford University Press, 1971).

[2]Our thanks to Professor Robert E. Snow for suggesting this set of four categories.

[3]Ernan McMullin, "Values in Science," pp. 1-25. For other discussions of scientific-theory evaluation, see W. H. Newton-Smith, *The Rationality of Science* (Boston: Routledge and Kegan Paul, 1981), pp. 226-32; Thomas S. Kuhn, *The Essential Tension* (Chicago: University of Chicago Press, 1977), pp. 320-39; and Del Ratzsch, *Philosophy of Science: The Natural Sciences in Christian Perspective* (Downers Grove, Ill.: InterVarsity Press, 1986), pp. 75-96.

[4]See Paul Davies, *Superforce* (New York: Simon and Schuster, 1984).

[5]We are using the term *folk science* in a manner similar to that of Jerome R. Ravetz in *Scientific Knowledge and Its Social Problems* (New York: Oxford University Press, 1971), especially pp. 386-97. Ravetz defines *folk science* as that "part of a general world-view, or ideology, which is given special articulation so that it may provide comfort and reassurance in the face of the crucial uncertainties of the world of experience" (p. 386).

[6]For a brief typology of positions on this question, see Ratzsch, *Philosophy of Science*, pp. 141-48.

Chapter 3: The Legend of the Shrinking Sun

[1]J. A. Eddy and A. A. Boornazian, "Secular Decrease in the Solar Diameter, 1836-1953," *Bulletin of the American Astronomical Society* 11 (1979):437. Note: this is only an abstract. The full text was never published.

[2]G. B. Lubkin, "Analyses of Historical Data Suggest Sun Is Shrinking," *Physics Today* 32, No. 9 (1979):17. The reference to the 1567 solar eclipse does not appear in the abstract (ref. 1), but can be found in this news report regarding Eddy and Boornazian's presentation.

[3]See the comments by Martin Schwarzschild reported in ref. 2. For an extensive review article which discusses these matters, see Gordon Newkirk, Jr., "Variations in Solar Luminosity," *Annual Review of Astronomy and Astrophysics*, 21 (1983):429-67.

[4]S. Sofia, J. O'Keefe, J. R. Lesh, and A. S. Endal, "Solar Constant: Constraints on Possible Variations Derived from Solar Diameter Measurements," *Science* 204 (1979):1306.

[5]Irwin I. Shapiro, "Is the Sun Shrinking?" *Science* 208 (1980):51.

[6]D. W. Dunham, S. Sofia, A. D. Fiala, D. Herald and P. M. Muller, "Observations of a Probable Change in the Solar Radius between 1715 and 1979," *Science* 210 (1980):1243.

[7]J. H. Parkinson, L. V. Morrison and F. R. Stephenson, "The constancy of the solar diameter over the past 250 years," *Nature* 288 (1980):548.

[8]R. L. Gilliland, "Solar Radius Variations over the Past 264 Years," *Astrophysical Journal* 248 (1981):1144.

[9]J. H. Parkinson, "New Measurements of the Solar Diameter," *Nature* 304 (1983):518.

[10]S. Sofia, D. W. Dunham, J. B. Dunham and A. D. Fiala, "Solar Radius Change between 1925 and 1979," *Nature* 304 (1983):522.

[11]C. Frohlich and J. A. Eddy, "Observed Relation between Solar Luminosity and Radius" [a paper presented at an international conference sponsored by the Committee on Space Research, July 1984 in Graz, Austria].

[12]Russell Akridge, "The Sun Is Shrinking," *Impact* No. 82 (Institute for Creation Research, April 1980), pp. iii, iv.

[13]See Thomas G. Barnes, "Evidence Points to a Recent Creation," *Christianity Today*, October 8, 1982, pp. 34-36.

[14]See *ORIGINS Film Series Handbook* (Phoenix, Ariz.: Films for Christ Association, 1983), pp. 11-12.

[15]In order to give due recognition to an important symmetry, we should note that just as scientific creationism functions as the folk science of contemporary Christian fundamentalism, so also naturalistic evolutionism functions as the folk science of modern Western naturalism. In each case, selected results of scientific investigation are interpreted in such a way that they may be employed to bolster a creedal tenet of a world view or ideology.

[16]Walter T. Brown, Jr., "The Scientific Case for Creation," *Bible-Science Newsletter*, July, 1984, p. 14.

[17]Henry M. Morris, *The Biblical Basis of Modern Science* (Grand Rapids: Baker Book House, 1984), p. 164.

[18]Hilton Hinderliter, "The Shrinking Sun: A Creationist's Prediction, Its Verification, and the Resulting Implications for Theories of Origins," *Creation Research Society Quarterly* 17 (1980):57; "The Inconsistent Sun: How Has It Been Behaving, and What Might It Do Next?" *Creation Research Society Quarterly* 17 (1980):143.

[19]See Lubkin, "Analyses."

[20]See Newkirk, "Variations."

[21]Hinderliter, "The Shrinking Sun," p. 57.

[22]Ibid., p. 59.

[23]Ibid.

[24]See Chapter IV, "Stellar Evolution and Nucleosynthesis," in *A Source Book in Astronomy and Astrophysics*, 1900-1975, edited by Kenneth R. Lang and Owen Gingerich (Cambridge, Mass.: Harvard University Press, 1979). This collection of original papers and editorial commentary provides an excellent overview of this important episode in the history of astrophysics.

[25]Hinderliter, "The Shrinking Sun," p. 59.

[26]James Hanson, "The Sun's Luminosity and Age," *Creation Research Society Quarterly* 18 (1981):27.

[27]See refs. 4 and 5.