Webs of Reality

Social Perspectives on Science and Religion

WILLIAM A. STAHL
ROBERT A. CAMPBELL
YVONNE PETRY
GARY DIVER

RUTGERS UNIVERSITY PRESS
New Brunswick, New Jersey, and London

Contents

PREFACE AND ACKNOWLEDGMENTS vii

Introduction: Finding a Place at the Table 1

Part I Soteriology

1 The Sacred Myth of Science 23

2 Writing the History of Science 37

Part II Saintliness

3 The Iconography of Science 53

4 The Newtonian Revolution 69

Part III Magic

5 Magicians, Reformers, and Scientists 85

6 As If by Magic 101

7 Technology as Magic 117

Part IV Theodicy

8 The Moral of the Dinosaur 135

Part V Mystery and Objectivity

9 The Science Wars 159
10 Naturalism, Science, and Religion 171
11 History and Hermeneutics 183
12 The Centrality of Dialogue 195

NOTES 205
SELECTED REFERENCES 225
INDEX 231

10 Naturalism, Science, and Religion

The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living.

—Henri Poincaré, *Science and Method*

One problem with the science wars is that they mystify science. The science wars, however, do raise some important issues for the science-religion dialogue. Alan Sokal and Norman Levitt, discussed at length in the previous chapter, represent an extreme conflict position in the context of what in chapter 4 we called metaphysical naturalism. This understanding of science leaves no place for religion. As we will demonstrate, metaphysical naturalism is an inadequate approach to science. An examination of how scientists, in particular physicists, approach the creation and validation of scientific knowledge will show that there is a relationship between the different ways of knowing reality and that there is nothing in science that necessarily excludes religion.

The Aims of Modern Science

Why scientists believe what they believe is as important as what they believe. The enterprise of modern science attempts to understand nature through posing and answering specific questions. This enterprise involves the creation of new hypotheses, the accumulation of evidence, the setting of standards of proof, and the validation of ideas through the institutional consensus of public knowledge.

Science is a human activity, and scientific work is a human construction that pragmatically attempts to be as objective as possible while balancing various human, traditional, institutional, and cultural forces that inevitably impact the enterprise. But ironically, the doing of science is more an art than a science, and scientific knowledge is always a work in progress involving this matrix of internal and external factors.

How one views reality is intimately related to the kinds of questions one is seeking to answer. These questions always reflect one's temperament, background, training, and culture. We will see that scientists are no exception, for they are constantly making choices about what to study, what instruments to use, and what theories to apply in their inquiries. And the answers they receive to questions posed to nature always require interpretation.

In essence, modern science involves a dialogue between scientists and nature. Hypotheses created in the minds of the scientists are used as vehicles to predict answers to the questions which scientists ask nature through controlled experiments. Modern science differs from earlier forms of science in its choice of questions and its attempt to interact objectively with an external world. This is also reflected in a shift in goals from descriptions of nature to the prediction of future events in natural systems. The significance and importance of this shift cannot be overstated: the laws of nature, which are based on things we have observed and measured, allow us to know in the future about things we have not observed or measured.

The development of modern science was aided by two historical shifts in human attitude and perspective. By restricting the scope of questions to be answered and problems to be solved, it was possible to develop an understanding that was qualitatively different from earlier understandings. In chapter 5 we outlined some of the ways in which this change in perspective came about. Science as we know it today was born on the day that people stopped asking why a particular stone fell upon a certain workman on a specific day and started asking how stones fall in general. From a prescientific perspective, it would have been natural to personalize this event and ask what this person did to cause the stone to fall on him. The scientific viewpoint rejects the idea that every event that occurs is unique and is directly caused by our personal relationship with the gods, God, or the stars. In the scientific way of thinking, events on Earth are not caused by actions in the heavens or the spirit world. With this change in perspective, science became decoupled from religion and began to ask different questions and expect different answers. In general, scientists are concerned not with why things happen, but with how they happen. This reflects the pragmatic frame of mind of most scientists and the adoption of utility as the primary criterion in science for determining understanding, truth, and value.

The second change involved an ethos shift during the Scientific Revolution of the seventeenth century from general philosophical questions to specific problems that can be solved in detail.[1] For modern science, it is only through the specific that the general can be identified and elucidated. This approach to science as problem solving has evolved to become the guiding aim of modern science.

Scientific Questions, Evidence, and Validation

What is the justification for the credence, belief, and trust in the accepted facts, conclusions, and pronouncements of the scientific community? How do we know for sure that the mass of an electron equals 9.11×10^{-31} kg or whether electrons really exist at all? Physics is not an exact science, but it is a quantitatively experimental science that always must deal with uncertainties. Though there are always alternative reasons for things happening in the natural world, the important question is, what is the best or most likely reason? The justification of scientific knowledge ultimately is that it is based on the criteria and standards developed and accepted by the scientific community.

It is important to remember that the enterprise of modern science involves three distinct aspects: first, the creation of hypotheses; second, the verification or falsification of hypotheses; and third, the validation and acceptance of a hypothesis by the scientific community. The creation of hypotheses involves a combination of persistence, talent, intuition, imagination, timing, and luck. It is very difficult to come up with plausible new hypotheses that are substantive, useful, and testable, and the process of how good hypotheses occur to scientists is very difficult to explain. In fact, most scientists go through their careers without coming up with a single important hypothesis that later became confirmed.

The verification of any scientific idea usually involves the careful and critical correlation of interdependent work of many scientists from many different labs in many countries. The scientists involved in the verification process often bring along auxiliary baggage that creates conflict with other scientists. Often it is difficult to determine whether scientific conflicts are conflicts over substantive data, interpretations, and issues or whether the conflicts are really personality clashes or differences in traditions or values.

Ideally, scientists should attempt to falsify or disprove their proposed hypotheses, that is, challenge the appropriateness and validity of their own ideas and understanding. In reality this rarely happens; instead most scientists try to confirm the validity of their ideas. The falsification of hypotheses by third parties is a process more likely to occur when there are rival hypotheses that are inconsistent with each other in a profound way within a larger theory. Ultimately one of the hypotheses will have to exit the intellectual stage, leaving the survivor as the “best” or most appropriate hypothesis under the given circumstances and evidence.

The final aspect of the scientific enterprise is validation by the scientific community. This is a communal activity involving the hierarchy and the political dynamics within the appropriate scientific field. The British physicist John Ziman has developed a very useful perspective and understanding of the enterprise of modern science that is based on the concept that science is public knowledge.[2] The growth of science then becomes the process of developing a consensus of this public knowledge by the scientific community. Individual and institutional communications, networks of trust, and institutional dynamics play pivotal roles in how scientific knowledge progresses through validation. An example of the complex dynamics of this process was demonstrated in chapter 8, which dealt with the controversy over the extinction of the dinosaurs.

Models and Theory

Newtonian mechanics was the first closed system of mathematical physics; in fact, it can be thought of as a branch of experimental mathematics. Its structure naturally led to the decoupling of the general laws of nature and the specific models created for each system of objects being studied. The revolutionary separation by Newton of theory from the specific models used to study various systems of nature is a feature that has continuously been used in physics.[3] Interestingly, Newtonian theory was really Platonic in nature in that it dealt with ideal concepts and principles that, even in principle, were neither directly observable nor testable.[4]

In the Newtonian system, as in the Euclidean system of geometry upon which Newton modeled his work, a theory involving concepts and principles is constructed to be logically true, while the approximations (and shortcomings) always come in the models. In practice, one assumes the theory to be true; it is then applied to specific cases in nature through the models for those systems. In the Newtonian view of physics, theory represents an ideal facsimile or verisimilitude of the structure and behavior of nature, while the physical models represent an actual sampling of nature.

The testing of Newtonian mechanics is always done within the context of a model of some specific system, which always includes a set of assumptions and simplifications. Each model has its own set of assumptions and simplifications and is therefore unique. The model approach of Newtonian mechanics and the controlled experimental testing of hypotheses combine to naturally suggest a selection of problems to be studied by physicists. It is profitable to attack specific problems that are, at least in theory, quantitatively solvable using mathematical techniques. These problems are usually relatively simple problems that are idealized and treated as a series of successive approximations to reality.

In order to solve any physical problem, one must be able to set up a model that is realistic enough to be relevant while at the same time simple enough to be solved mathematically. The first step in this process, and probably the most important one, is choosing what is essential and what details can be left out of the model. As William James once remarked with profound insight: "As the art of reading (after a certain stage in one's education) is the art of skipping, so the art of being wise is the art of knowing what to overlook."[5]

Physicists are not interested in the truth, the whole truth, and nothing but the truth. In fact, if we could know everything about the world, we would be overwhelmed and understand nothing. For example, if we could actually see atoms, the nearly infinite number of atoms impinging on our senses would cause us not to be able to see beyond the thin layer of atoms next to our eyes, and we would be effectively blind. Too much information can be disabling; it is important to be selective in what to use and how to use it. Ultimately these important choices are intuitive, based on experience and imagination, and reflect the talents and judgments of the individual scientists.

One cannot do controlled experiments without breaking down the relevant system into its smallest components. The way physicists study nature is similar to the operation of CT scans, where carefully chosen two-dimensional slices can be used to reconstruct the whole three-dimensional organism. This reconstruction involves the solution of the inverse problem that attempts to determine what the whole entity actually is from what carefully selected segments appear to be. Physicists understand their sample systems through a series of successive approximation models. They identify and eliminate all possible complicating factors in order to construct the simplest possible model that can still realistically describe the essential features of the system. After this simplified model is analyzed and understood, complicating factors (complexities) are added to the model one at a time in order to make it more realistic and more closely correspond to the real system that they are modeling.

Platonism, Realism, Truth, and Objectivity

In essence, theoretical physicists create a parallel universe in mental space that is a conceptual template in which empirical facts can be correlated and analyzed, and that also can be used as a computational tool to crank out answers to questions posed to nature through controlled experiments. This Platonic conceptual universe is an acceptable facsimile of nature if, and only if, it can correctly predict answers to future questions submitted to nature by empirical testing. Ideally, the conceptual framework of a theory will suggest significant questions to pose to nature which have never been asked.

Objectivity and Quantum Mechanics

The scientist is strongly coupled to nature through the questioning process, which uses various ideal conceptual models of nature and whatever instrumentation is employed to ask the questions. This view of modern science as inquiry was significantly extended and modified during the 1920s by the development of quantum mechanics, which suggested a change in what was considered possible to know about nature. The fundamental outcome of the "quantum crisis" in early-twentieth-century physics was the realization that "whatever fundamental units the world is put together from, they are more delicate, more fugitive, more startling than we catch in the butterfly net of our senses."[6] Werner Heisenberg discussed the significance of this change: "Natural science does not simply describe and explain nature; it is a part of the interplay between nature and ourselves; it describes nature as exposed to our method of questioning."[7] An important corollary to Heisenberg's observation is that strict objectivity, at least at the quantum level, does not and cannot exist.[8] Nature and the scientist are coupled through the experimental process and become more coupled as the questioning becomes more intimate. Modern twentieth-century physics is essentially a questioning process that says less about the nature of nature and more about what we can ask and say about nature.

It should be emphasized that the observer-system dilemma in quantum mechanics is not incompatible with the traditional aim of objectivity in science. Classically, the strong version of objectivity is viewed as the separation of the observer from the system he or she is studying.[9] The weak version of objectivity represents the dispassionate approach a scientist takes toward her or his work. Instead of aiming for complete objectivity, scientists today generally strive for the best objectivity possible under the circumstances.

Practically viewed, then, one can speak of degrees of objectivity. This involves a deliberate attempt to be impartial and dispassionate in one's research and to be detached from the outcome of that work. Certainly one should strive to avoid injecting one's politics, religious views, ambition, or personal conflicts into scientific observations, analyses, interpretations, and pronouncements. Thus, the contemporary view of objectivity is less a condition and more a pragmatic attitude toward one's work.

Varieties of Scientific Truth

There is a major caveat for this philosophical discussion that also applies to many other general analyses and discussions about "science" and "scientists." The problem is simply that there is no generic science or generic scientists. When people talk about "science" or "scientists," they are referring to a generalized ideal that does not exist.

Scientists are really astronomers, physicists, chemists, biologists, geologists, and so on, and these different kinds of scientist view and deal with the natural world in profoundly different ways. The division of labor in the scientific enterprise also affects the different perspectives typical of theoreticians and experimentalists. Theoretical physicists, for example, tend to see, understand, and appreciate the universe in vastly different ways than do observational astronomers.

It is possible to gain some general insight into the mindset of scientists by comparing the perceived relationship between nature and science typical of theoretical physicists with that typical of observational astronomers. The theoreticians tend to see the nature/science reality in terms of a trinity consisting of nature, theory (which is necessarily idealized), and models. The models for the particular systems being studied act as intermediaries between nature and scientific theories. Theory is usually treated in the same fashion as Newton treated his theory in the *Principia*, that is, as an axiomatic, deductive system patterned after Euclid's geometry. After the individual concepts and principles have been adequately tested and verified and successfully incorporated into a general theory, these components are assumed to be true as they are applied to various models.

Is this conceptual world real? The answer depends on one's relationship to it. As physicist John Barrow points out: "Most scientists and mathematicians operate as if Platonism is true, regardless of whether they believe it is. That is, they work as though there were an unknown realm of truth to be discovered."[10] If the importance of something is measured in terms of what it causes one to do, then to most scientists this imaginary world seems real because they act upon the belief that it is real.

Observational astronomers are probably closer to other scientific disciplines in their view of the relationship between nature and science than are theoretical physicists. Astronomers tend to be empirical model builders who view nature/science as a doublet consisting of nature and their empirically constructed models that are continually being revised. Astronomers pragmatically take the concepts and principles from physics, chemistry, and geology as needed to build the appropriate models that correlate the information that their instruments have yielded them. Few astronomers believe their models are real or that they will survive to be actively used in research fifty years into the future.

The Scientific View of Reality and Its Limitations

The scientific view of reality has been successful and influential far beyond the scientific laboratories. In fact, our modern society is based upon the fruits of scientific perspectives and research.

But this worldview has limitations that should be acknowledged and understood in order to prevent abuses and unrealistic expectations. The limitations of the scientific viewpoint and approach can be grouped into three categories: epistemological, systematic, and cultural.[11]

The two major epistemological features of modern science are the questioning of nature through controlled experiments and the mathematical modeling of the systems of nature being studied. Controlled experiments are the best-known method of testing scientific hypotheses, but there are a number of limitations that influence the interpretation and meaning of the experimental results. First, all data are theory laden, that is, they are embedded within some theoretical framework. Second, hypotheses always involve a set of associated assumptions, and third and finally, hypotheses are almost never tested individually. In most cases, a group of hypotheses and their associated assumptions are tested as a unit that requires an interpretative analysis. And, of course, there may be some truths about nature that are not discernable through controlled experiments.

Constructing the laws of nature in mathematical terms and using mathematical models are very powerful approaches for examining patterns, relationships, and interrelationships among observed phenomena. Though extremely powerful as a system and as an analytic tool, the mathematical approach to understanding nature shares the limitations of the system of mathematics being applied.[12]

Science has been very successful at uncovering and elucidating relationships among natural phenomena, especially phenomena connected through causal relationships. In a real sense, this ability to predict the future behavior of nature is the strength of science.[13] But as was discovered and analyzed by David Hume, this edifice of knowledge is built on soft ground.[14] The only reason we can say with confidence that the sun will rise tomorrow is that from past experience it always has risen. The scientist's ability to predict the future of natural events depends on inferences from the past and present that are projected into the future. Bertrand Russell pointed out that a similar problem exists with the validity of induction.[15] Scientific predictions are based on past experiences, and it is impossible to know definitely whether scientific principles applied to a new system will be valid for that system until they are tested.[16] The problems of causality and induction are examples of the general paradox of human understanding, in that it is always easy to believe more than you can prove or know for sure. The laws of nature themselves place some limits on what is measurable and what is knowable. Heisenberg's uncertainty principle, in particular, places a restriction on our access to the microscopic world.[17] Whether this restriction reflects the limitations of our knowing or whether it represents a basic reality of nature has been an issue of debate for more than sixty years. At the quantum level, we have reached a level of nature that is impossible to perceive in terms of simple classical ideas, models, and experiences.

Science, Religion, and the Webs of Reality

Based on our study of how science works, it is clear that science is an interpretive activity requiring human choices at each step of the various processes. These choices are resolved through a combination of intelligence, tradition, communal interactions, and contingency. This interpretive aspect of science is the key to understanding how science relates to other ways of knowing. We argue that the scientific view is certainly very important, but that other approaches to reality also need to be included in our lives and in our understanding of the universe.

Hidden within the conflict over objectivity and realism are the important issues of boundaries and authority. Ultimately this has to do with who gets a voice in determining what is acceptable knowledge and what is the official understanding of the reality that this knowledge implies. On one level these issues reflect a contest for power within society. This relates to our argument for a more open process of inclusion among the relevant players in the science-religion debate. The question of boundaries can be viewed as a struggle between an elitist vision of reality decided by a small number of experts, and a more democratic process of determining who gets a say in the outcome. And as with most issues, it is the extremists who define the arguments, but it is the moderates who live peacefully with each other.

Certainly one extreme view involves the belief that science is the only way to truth. Actually this attitude has a long history going back to the empiricism of John Locke, who viewed sensory experience as the primary source of knowledge and the justification of the truth of propositions. In the early nineteenth century, Auguste Comte proposed positivism as a system of philosophy based on accepting as true knowledge only personal experiences and empirical information of natural phenomena. Reality consisted only of this defined world of empirical facts and logic and mathematics. This belief system became the basis of a later philosophical movement called logical positivism that rejected all metaphysics and believed that all human understanding eventually would be in the form of science. This movement was ideological and promoted an agenda that was material, antimetaphysical, and secular (antitheological). So we see that there was an earlier effort to reduce the ways of knowing to those that could be put on a strict logical basis using empirical data.

But is science the only method to obtain truth, the only valued way of knowing? Certainly this claim is ultimately an ideological dogma and not a scientific or philosophical position. This ideology is also associated with the views of scientific materialism, scientism, and metaphysical naturalism. Materialism is the belief that matter is the basis of all of reality, while scientific materialism is associated with the metaphysical belief that a scientific explanation of matter is a sufficient basis for explaining all of reality. Scientism, which is similar to scientific materialism, is the claim that the only truth is scientific truth and that the only path to knowledge is the path of science. For our purposes, the attitude of scientism has its origins with a later development of positivism by a group of German and Austrian philosophers in the 1920s, referred to as the logical positivists. This school was greatly influenced by developments in formal logic, and it played a dominant role in the philosophy of science for the following half century. Though logical positivism has since lost its dominant position, issues in the philosophy of science are still often framed in terms of a response to logical positivism. Usually scientism is expressed as the belief that the methods of science can and should be used in all fields of investigation. (It should be pointed out that *scientism* is considered a pejorative term and is almost always applied by critics of science to certain scientists who are viewed as promoting a dominating role for science in society.)

One hotly debated issue in the interdisciplinary study of science and religion is the distinction between methodological naturalism and metaphysical naturalism.[18] The use of methodological naturalism restricts explanations of natural phenomena to natural processes and rejects any supernatural influences. Metaphysical naturalism goes one step further and categorically claims that supernatural phenomena and influences do not exist. The adoption of this metaphysical principle by some scientists implies the explicit rejection of a soul, a spirit world, any supernatural influences in the universe, and any God who can directly interact with the universe. The implications of this belief for religion are obvious and draconian.

Any scientist who insists on imposing metaphysical naturalism is guilty of scientism. This involves usurping the boundary between science and religion and claiming all of reality for science. In essence, this would be a form of atheism imposed by fiat and a reconciliation of science and religion by eliminating religion as it is known by most people. This consequence implies that the role of naturalism in science is a fair topic for both scientists and believers to examine and debate. Thoughtful pleas against the excesses of scientism have recently been made by the respected environmental farmer, poet, and essayist Wendell Berry and by the dean of religion writers, Huston Smith.[19] They eloquently argue that any claim of "one way" is hollow and diminishes all of us.

According to Chet Raymo, one useful way to avoid domination by one side or the other is to look at the science-religion debate in terms of skeptics and true believers.[20] True believers are people who believe that their way of knowing is the only way. They have a tendency not to listen to or care about alternative viewpoints and to believe that they are sure they know the truth. This confidence of having superior knowledge creates an inability to live with ambiguity and a need to impose a single belief or restrictions on others.

It is very tempting to claim the right to draw the boundaries between science and the other constituents of society. But it is also very dangerous to claim the power that is implied in that right. The boundaries between different human enterprises should be freely negotiated among the various interested parties and not forced from above by an intellectual elite. But in either science or religion, it is the true believers who have a need to draw sharp boundaries and define what other people are allowed to do and to believe.

At the other extreme of boundary drawing is the desire to integrate science and religion. One of the alternative methods of integration involves restructuring religion to be consistent with the philosophical foundations of science. This approach seems popular today and can be seen in the various versions of process theology, among others. These theologies seem to be built upon a foundation of modern science and tend to associate God with a universe that is growing in complexity and potential. As in the case of scientism, the integration of science and religion reduces the possibilities of ways of knowing and the ways of relating in the world.

A respect for other viewpoints does not include mergers by elite intellectuals to create a forced harmony. All the players, including ordinary scientists and the believers in the pews, should be allowed to participate in drawing the boundaries and deciding on the functions allocated to the different enterprises. Reality is too important to be left to the elites.

One way to encourage the sharing of reality is not to view reality as a single flat plane to be either divided up or taken over. It would be better to view reality as a multifaceted entity that requires multiple maps to fully understand its nature and purpose.[21] These maps should not be viewed as competing alternatives, but as complementary understandings seen through different filters constructed from different experiences, traditions, values, and goals. In essence, these maps represent different layers of meaning that correspond to the different dimensions in which humans understand and relate to the universe.

Science is a wonderful and powerful way of knowing and understanding the universe, but it is only one of many ways of relating to and appreciating it. We have argued that it is possible to recognize and honor science without taking away from the other approaches that humans have taken to relate and enrich their lives.[22] One does not need to know any acoustics to appreciate beautiful music, but having knowledge of acoustics could further add to its appreciation. The beauty and appreciation of a flower, as Richard P. Feynman passionately maintained, can be viewed and understood from multiple human lenses and perspectives that complement each other.[23]

Reality is a complex web with many strands, and our future will be only as interesting and robust as the number of strands we allow in the web. The universe, including humans and their societies, is an amazingly rich source of content, meaning, and opportunity. Adopting a position of pluralism would allow this richness to be appreciated, shared, and developed in a way that will make our lives even richer. The various ways of knowing and appreciating our world should complement each other instead of competing in a winner-take-all contest for reality.