ACCEPTABILITY CRITERIA FOR WORK IN THEOLOGY AND SCIENCE

by Nancey C. Murphy

Abstract. The philosophy of science of Imre Lakatos suggests criteria for acceptability of work in the interdisciplinary area of theology and science: proposals must contribute to scientific (or theological) research programs that lead to prediction and discovery of novel facts. Lakatos's methodology also suggests four legitimate types of theology-and-science interaction: (1) heuristic use of theology in science; (2) incorporation of a theological assertion as an auxiliary hypothesis in a scientific research program, or (3) as the central theory of a research program; and (4) hybrid theology-and-science programs with empirical data. Three recent *Zygon* articles illustrate these four types.

Keywords: Imre Lakatos; relation between theology and science; theories, acceptability criteria for.

The purpose of this paper is to propose criteria for acceptability of theses in the area of theology-and-science. By *theology-and-science* I mean to refer to work that combines concepts or information from both science and theology. A first glance at the literature suggests that an assortment of strategies are employed. Some authors argue to theological conclusions from scientific facts or theories—for example, from the fact of evolution it follows that the model of *creatio continua* is of prime importance in theology (e.g., Peacocke 1984). Others reverse the order of argument—from the doctrine of *creatio ex nihilo* to the big bang theory of the origin of the universe (for a critical discussion see McMullin 1981). Still others point to correspondences between concepts—for example, Karl Peters suggests that the Christian concepts of *spirit* and *word* refer to the same processes as do the thermodynamic concepts of *fluctuation* and of *ordered, stable states* when used to

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describe the creation of complex stable states from less complex ones (Peters 1987). In some cases theological and scientific concepts are combined into an entirely new system not readily identifiable as either science or theology, but such a system might rather be classed as a hybrid. As examples I suggest contemporary process thought (see, for example, Birch & Cobb 1981) or the work of Teilhard de Chardin (1959). There may be more strategies besides.

In the following pages I shall describe a promising theory of scientific growth from which it will be possible to derive criteria for acceptable work in theology-and-science and also to develop a typology for legitimate contributions to this field. I shall then examine three recent *Zygon* articles, showing that they provide instances of each of my four types.

The Problem

For any who may doubt the need of acceptability criteria for projects such as these, I offer two considerations. The first is simply to point out the lack of agreement among competent thinkers regarding the value of various contributions to this field. Recall the great furor aroused by Teilhard's work among both scientists and theologians. Even if none of the examples I have mentioned above seem controversial, be assured that examples could be found.

The second consideration I wish to raise is philosophical. Certain highly regarded theories in the philosophy of language regarding the means of establishing the meaning of discourse present a serious challenge to theology-and-science theoreticians. This challenge is not aimed at the acceptability of particular theses; rather it questions the meaningfulness of every such theory. Although a number of philosophers participated in bringing about a revolution in philosophy of language in our century, I shall concentrate here on the work of Ludwig Wittgenstein (1889-1951).

Wittgenstein developed two different theories of the nature and meaning of language during his career; the second is diametrically opposed to the first. In fact his later book *Philosophical Investigations* (1953) is an attack upon the theory expressed in his *Tractatus Logico-philosophicus* (1922). In the *Tractatus* Wittgenstein developed a *picture theory* of language wherein words are names of elementary objects and sentences are pictures of states of affairs in the world. There are many different kinds of pictures, for example, stylized primitive art, maps, photographs, representational paintings—Wittgenstein even calls a musical score a picture of a melody. A (true) sentence is a picture of a fact because it depicts a particular state of affairs. For example, in the sentence "The cat is on the mat," *cat* and *mat* name their two respective

objects; *on* is the name of the spatial relation between them; and the order of the sentence *shows* how these three are to be put together. This sentence is one way among many of picturing this state of affairs involving the cat and the mat.

By the time he wrote the *Investigations* Wittgenstein had rejected the picture theory as entirely inadequate to the complexities of actual language use and adopted instead the thesis that the meaning of a sentence is determined by the way it is used in various sets of circumstances. To clarify this point he introduced the concept of a *language game* (*Sprachspiel*). Just as swinging a stick may be a strike in the circumstance of playing a baseball game, so saying various strings of words may constitute plays in particular language games: one may make an assertion, form a decision, ask a question, make a request, give an order, or any one of countless other possibilities. In the baseball example it is not that the individual components (player, plus bat, plus swing, plus missing the ball) all add together to compose the fact of the strike. Rather, it is the circumstances of the game—the setting, the intention to play, the rules—that make the strike a strike and even make the person a player and the stick a bat. In like manner, it is not adding together a string of words whose meanings are all definite (e.g., names of objects and relations) that makes the sentence a play in a language game, but the circumstances. The same string of words can be used for making more than one kind of play: "I'll walk him" given the setting and circumstances of the baseball diamond is a play in one language game (has one meaning or use) that is quite different from the move it represents in a family's discussion of who will take the dog out. The meanings of the part of the sentence (e.g., *walk*) are determined by the assortment of plays or sentences in which they can figure. Thus the dictionary, among its eight or so definitions of the transitive verb *to walk*, must offer meanings suitable to each of these two uses. *Use determines meaning*.

In his earlier work Wittgenstein claimed that any bit of language presupposed the whole of language. This was because he thought that sentences in natural language were really truth functions (compounds) of elementary propositions. Understanding complex sentences, then, requires understanding the elements, and given the elementary propositions all other possible compounds are foreseeable. This thesis was an a priori thesis derived from his view of the atomic nature of language. In his later work, however, he maintained a more plausible view, namely that, although a sentence presupposes a language game, that language game will be only a small segment of the whole of language. To see this, consider one of the simple language games he imagined. There are a builder and his helper. The building materials

are slabs, blocks, pillars, and beams. The two men have a language consisting of the words *slab*, *block*, *pillar*, and *beam*. The builder calls out one of these words and the helper brings him the type of stone corresponding to it. This is one complete language game; the builder and his assistant need to know no other language in order to participate in it. And participating correctly is all there is to knowing the meanings of the words. Such participation does not entail anything about other language games that might be available to them.

Ordinary language depends upon a variety of language games in which we have learned to participate. Some of Wittgenstein's examples are giving and obeying orders, describing objects, constructing objects from descriptions, forming and testing hypotheses, presenting the results of an experiment in tables, making up a story, playacting, guessing riddles, solving arithmetical problems, translating from one language to another, asking, thanking, cursing, greeting, praying. There is a great jumble of them involved in everyday language, and built on around the edges, as suburbs grow up around the edges of the old city, are the orderly languages of science, mathematics, and so on (Wittgenstein 1953, sec. 18).

At this point the challenge for theology-and-science is clear. Scientific discourse has definite meaning when it is used according to established practice within particular scientific-language communities. Likewise, religious languages have definite meaning within the various contexts of religious life and practice. Theological language also has its own proper sphere, related to some sphere of religious discourse. *Taken out of these contexts and transplanted to another we no longer know how to use the various terms and assertions appropriate to each of these fields (no longer have criteria for applicability of terms nor for acceptability of assertions).* In brief, the challenge is this: if work in theology-and-science is outside our established language games, then we have no rules for proper usage; therefore, there are good grounds for questioning its meaningfulness. For example, purported inferences from theology to science or vice versa are questionable since valid inference requires that the terms be used in the same sense in both premises and conclusion. Obviously, an inference about (air) planes based on premises about planes in geometry is nonsense. How do we know that inferences from scientific theories about the beginning of the universe to theological conclusions about the beginning of the universe are not also nonsense? Christians and Jews are accustomed to speaking about God existing *before* the universe was created. Yet for many cosmologists *before the big bang* has no determinate sense.

A Proposal

PROLEGOMENA. In the preceding section I have summarized a theory of language (meaning as use) that calls into question the meaningfulness of any discipline that combines the language of two different language games. I have not argued in such a short space that Wittgenstein's theory of language is the only option. However, I do claim that his work is significant enough in the eyes of the philosophical community that we in the area of theology-and-science must either show where Wittgenstein and others have gone wrong or else we must show that there are usable criteria (which we sometimes meet) for acceptable theory development in our new field. There is a note of encouragement in the fact that language cannot be static; extension of language into new areas is necessary if it is to be able to express growth in knowledge. Therefore, there must be criteria that govern not only use of language in established language games but also the very practices of developing and extending the language games themselves. If this is the case, such criteria will be just what we need to solve the problem at hand.

Not everyone believes that such criteria exist. Philosopher of science Paul Feyerabend is famous for his claim that there is no single scientific method that will work consistently to bring about progress in science. He claims correspondingly that there are no rules or criteria for development of new language. Every new world view (including major theories in science) begins its career, he says, as *nonsense*. In order to develop a language of the future "one must learn to argue with unexplained terms and to use sentences for which no clear rules of usage are as yet available. . . . [T]he inventor of a new world view (and the philosopher of science who tries to understand his procedure) must be able to talk nonsense until the amount of nonsense created by him and his friends is big enough to give sense to all its parts." "The terms of the new language become clear only when the process is fairly advanced, so that each single word is the centre of numerous lines connecting it with other words, sentences, bits of reasoning, gestures which sound absurd at first but which become perfectly reasonable once the connections are made" (Feyerabend 1975, 256-57). Feyerabend's position would suggest that science-and-theology *is* nonsense but that saying so is no criticism. We must simply go about our business without regard to philosophers' worries. Perhaps this is indeed what will happen. However, a second possibility is that rules *are* available (in either science or theology) for the extension of language and knowledge. This, and not Feyerabend's, is the avenue I shall pursue in the remainder of this paper.

Whereas it is not widely agreed that theology progresses (some see its task to be basically conservative—to repeat the original content in the concepts of one's own age), it is generally agreed that there is progress in science, that is, extension of our range of knowledge to new areas and discovery of new relations between existing areas. Therefore, the task of the next section is to examine the best of the available theories about the rules for the growth of science to see if that theory provides the necessary guidance for relating science to theology. I shall claim that it does and that those contributions to theology-and-science that meet the criteria it proposes, by that very fact, meet the challenge posed regarding the meaningfulness of the language involved.

A PROPOSAL FROM PHILOSOPHY OF SCIENCE. The history of the philosophy of science, at least since the days of the logical positivists, might well be described as the history of attempts to set forth the grammatical rules for the use of such terms as *meaningful*, *true*, *justified*, and *acceptable* as applied to scientific theories. The logical positivists proposed a verificationist theory of meaning to the effect that whatever was not at least potentially verifiable on the basis of sense experience was meaningless. In his earliest work *The Logic of Scientific Discovery* ([1935] 1959) Karl Popper made it appear rather simple to provide the rules for the scientific language game. In essence they came down to this: accept the theory that is the most highly falsifiable, yet not in fact falsified.

Then there came the philosophers of science who were also historians of science, such as Feyerabend and Thomas Kuhn. Both pointed out that science does not obey rules so simple and clear as Popper claimed. Kuhn's contribution might be understood by means of this analogy. If Popper saw the task of philosophy of science to be analogous to setting forth the rules of chess, Kuhn would say that the "rules" of science are more like maxims for good chess strategy (Kuhn 1970). On the other hand, Feyerabend claimed that any proposed rules are as likely to inhibit as to foster the progress of science, so in effect there are no rules (Feyerabend 1975).

In reaction to the critical work of Feyerabend, Kuhn, and others, philosopher of science and mathematician Imre Lakatos has led a renewed attempt to propose criteria for the justification of scientific theories. His hope was that his new methodology (theory of scientific reasoning), based upon a more sophisticated understanding of the history of science, would prove a more adequate guide than those of neopositivists such as Popper. In Lakatos's essay entitled "Falsification and the Methodology of Scientific Research Programmes" (1970a) he made it plain that his intention was to continue in the positive tradition of Popper while taking account of the criticism to which Popper's work was subject when compared with the actual history of science.

Lakatos characterized the rationality of science by specifying a criterion for choice between competing research programs. A research program includes a theory and a body of data. Conjoined with the theory are a set of auxiliary hypotheses that together add enough information to allow the data to be related to the theory. Examples of types of auxiliary hypotheses are theories of observation or of instrumentation, lower level theories that apply the main theory in different kinds of cases, and so on. The main theory is called the hard core of the research program, and the auxiliary hypotheses are said to form a protective belt around it, since they are to be modified when potentially falsifying data are found. A research program, then, is a series of complex theories whose core remains the same and whose auxiliary hypotheses are successively modified, replaced, or amplified in order to account for problematic observations.

Lakatos claimed that the history of science is best understood not in terms of *successive* paradigms (as it is for Kuhn) but rather in terms of *competing* research programs. Some of these programs Lakatos described as progressive and others as degenerating. A degenerating research program is one whose core theory is saved by *ad hoc* modifications of the protective belt—mere face-saving devices or linguistic tricks, as he calls them. We all have a sense of what these expressions mean, of course, but it is difficult to propose criteria by which to rule out such nonscientific maneuvers. The heart of Lakatos's methodology is his characterization of the kinds of maneuvers that *are* scientifically acceptable. A research program is *progressive* in Lakatos's terms when the following conditions are met:

1. Each new version of the theory (core theory plus its auxiliaries) preserves the unrefuted content of its predecessor;
2. has excess empirical content over its predecessor, that is, it predicts some novel, hitherto unexpected facts; and,
3. some of these predicted facts are corroborated.

When the first and second conditions are met a theory is said to be theoretically progressive. When all three are met it is empirically progressive as well. From this the contrary follows. A research program is *degenerating* when the change from one theory to the next at most accounts for the one anomaly or set of anomalies for which it was made but does not allow for prediction and discovery of any novel facts. The choice of a theory thus becomes a choice between two or more competing *series* of theories, and one chooses the more progressive of the programs. The choice is thereby made to depend on the programs' relative power to *increase* empirical knowledge.

Lakatos distinguished between mature and immature science. In mature science a research program involves both a negative and a

positive heuristic, that is, plans for future development of the program. The negative heuristic is simply the plan (or methodological rule) to avoid falsification of the hard core—to direct the *modus tollens* against the auxiliary hypotheses and make suitable modifications among them. This aspect of the heuristic takes account of the fact emphasized by both Feyerabend and Kuhn that comprehensive theories need time to develop before they can be judged; a certain amount of dogmatism, they say, is essential to science. Both mature and immature programs are characterized by a negative heuristic—without the decision to pursue and defend some central theory there is no program.

Mature science differs from immature science in that the development of the auxiliary hypotheses in mature science proceeds according to a preconceived plan: the positive heuristic. This is "a partially articulated set of suggestions or hints on how to change, develop the 'refutable variants' of the research-programme, how to modify, sophisticate, the 'refutable' protective belt" (Lakatos 1970a, 135). In other words, the positive heuristic sets out a program for a chain of ever more complicated *models* simulating reality. The simpler models are known ahead of time to have numerous counterinstances. However, adjusting for these expected anomalies is already anticipated in the plan to elaborate more complex models.

It is now possible to summarize Lakatos's proposal for acceptance of scientific theories. His view is that there is objective reason for choosing one program over another when the former has a more progressive record than its rival—that is, *a greater demonstrated ability to anticipate novel facts*.

In conjunction with this general theory regarding criteria for choosing among scientific theories, Lakatos discussed briefly the conditions under which various modifications of existing programs are to be accepted—for example, a program created by grafting together two formerly independent programs or theories. This discussion is more specifically of the question of the acceptability of grafting together two inconsistent programs, but what holds in the more difficult case of inconsistency will hold in the simpler case of two completely independent programs. Considering historical examples such as the grafting of Niels Bohr's program of light emission onto the Maxwell-Lorentz theory of electro-magnetism, Lakatos showed that such hybrid programs are acceptable so long as they continue to be empirically progressive in the sense defined above. Lakatos also discussed cases of "semantic reinterpretation" of theories—that is, changing the meaning of a theory to account for anomalies. Again, the criterion by which to judge such maneuvers is empirical progress. If the meaning change only solves the problem that motivated it and allows for prediction of no novel facts, then it is a degenerative move—mere face-saving.

We see, then, that Lakatos's criteria for acceptability of scientific theories specify conditions under which scientists count a new move to be an instance of the growth of knowledge. Research programs are constantly amplified in order to take account of new data. When they do so in a progressive manner the additions count as added knowledge. When two existing theories are grafted together into a unified research program, it is counted as a genuine increase in knowledge if the new program allows for prediction of facts that the two taken separately did not. Alteration of the meaning of terms in a theory can also count as an increase in knowledge if it is associated with prediction of novel facts. Finally, when a major theory is proposed, it is to be counted as an advance only if it is more progressive than its existing rivals. New theories are proposals for new uses of language and should be accepted when they yield new discoveries.

In short, Lakatos's methodology provides a basis for making two important distinctions. Science is to be distinguished from nonscience on the basis of its organization into *research programs*. Acceptable science is to be distinguished from unacceptable proposals on the basis of its *empirical progress*.

I have only reported on Lakatos's work here; I have not argued for its acceptance. Space is too limited to do so, but the lines one would have to take to show that his is the best understanding of the rules of scientific discourse are the following: First, examine his claim that his methodology explains more of the history of "good" science than do any of his rivals (Lakatos 1970b); second, test his methodology against more of the history of science that he has considered and review work done along these lines by his followers (for a few examples see Monod 1981; Cushing 1982; and Archibald 1979); third, see what answers can be made to philosophical criticisms of his position;[1] and, fourth, examine theories more recent than his to see whether they are better than his (see Laudan 1977). I believe that a thorough investigation of this sort would bear out my claim that Lakatos's methodology is the best available today.

Application to Theology-and-Science

ASSESSMENT CRITERIA FOR THEOLOGY-AND-SCIENCE. As stated above, Lakatos's methodology provides criteria for distinguishing science from nonscience and for distinguishing acceptable scientific theories and modifications of theories from those that are unacceptable. It would be useful at this point to have a widely accepted theory of acceptability criteria in theology, but I believe it is fair to say that there is little agreement on this point among theologians. The need for such a theory can be seen from the following considerations. We have been

asking in this paper whether it is meaningful to combine discourse from the separate fields of theology and science, for example, arguing from a scientific position to a theological conclusion or vice versa. Schematically these two possibilities may be represented thus:

$$(1)\quad \frac{S \qquad S \rightarrow T}{T} \qquad\qquad (2)\quad \frac{T \qquad T \rightarrow S}{S}$$

where *S* stands for a scientific assertion, *T* for a theological assertion, and $S \rightarrow T$ for the assertion that T (in some sense) follows from S. Note that I do not mean to say that S logically implies T, which is too strong a claim, since the question at issue is just what, exactly, such an arrow might represent.

A minimal condition for assessing the acceptability of (1) is that we know what is required for the acceptability of S. (This is analogous to the need for truth-criteria for premises in assessing a deductive argument.) Based upon the theory of scientific methodology described above we conclude that S must be a part of a progressive research program. Assessment of the argument also requires some independent test of the acceptability of the theological conclusion T. Correspondingly, schema (2) leads us to ask for comparable criteria for the acceptance of its theological premise.

I am currently at work on a book showing that some theological schools can be construed as *theological research programs* with hard cores, auxiliary hypotheses, positive heuristics, and their own domains of data. Furthermore, I argue that Lakatos's requirement to account for counterevidence in a progressive manner is as germane to theological reasoning as it is to scientific. However, since I cannot reproduce that work here, I merely suggest that our considerations so far point to a great need for agreement on criteria for acceptance of theological theories. Just as we hope to avoid linking theology with bad science, we surely must avoid attempts to link science with bad theology.

Since I cannot support my claim here that theology is (or can be) formally identical to science, we must concentrate our attention on possibilities for assimilating proposals in theology-and-science to various forms of *scientific* growth, for the present counting parallel proposals regarding theological growth as much more tentative. I therefore propose that we employ Lakatos's acceptability criteria for evaluating contributions to the field of theology-and-science; contributions to this field shall be counted acceptable insofar as they contribute to *research programs* that are *empirically progressive*—that is, lead to the discovery of novel facts.

FOUR STRUCTURES FOR RELATING THEOLOGY AND SCIENCE. If empirical progress is to be the criterion for acceptance of proposals in theology-and-science, a necessary prerequisite is that work in this area exhibit the structure of research programs, since empirical progress *is* a characteristic of research programs. In this section I shall suggest *four ways* theology may play a role in scientific research programs. Keep in mind the possibility, however, that there may be theological research programs as well and that each of the first three types could be reversed with science contributing in a comparable manner to theology.

Theology may play a heuristic role in science. Lakatos's methodology calls for evaluation of a program on the basis of its contribution to the growth of knowledge, not on the basis of its source. Hard cores of successful research programs have come from various sources, including metaphysics and theology. Therefore, it is perfectly in keeping with this methodology to advocate research on scientific theories that appear to be consonant with a theological position. Articles claiming that theological positions suggest scientific conclusions may be read as proposals to interested scientists to pursue research programs incorporating those scientific conclusions.

Theological theories may function as auxiliary hypotheses in scientific research programs. An even more interesting role for theology is the incorporation of a theological proposition into a scientific research program. If one takes seriously the view of most recent philosophers of science that science is constituted not by its content but by the method employed, it follows that any proposition that can be treated in a scientific manner (which means here its incorporation into a progressive research program) is scientific. Philosophers have considered whether metaphysical propositions can become scientific or can profitably be used in scientific theories and have concluded that this is sometimes the case. Thus, nothing prohibits similar use of appropriate theological assertions. Recall that the function of auxiliary hypotheses is to spell out the meaning of the hard core and to provide links by which it is logically related to the data. One possibility, therefore, is incorporation of a theological assertion as an auxiliary hypothesis in a scientific research program.

A theological position may become the hard core of a scientific research program. Just as a theological assertion becomes scientific by its incorporation as an auxiliary hypothesis in an existing research program, a theological theory may become the hard core of a scientific research program. In such a case, the theological language becomes scientifi-

cally meaningful as the program is developed around it and it is related to appropriate data.

Theology and science may be combined in a hybrid research program. A final possibility is a research program in which the scientific or theological origin of particular components is not readily apparent. In such a case an entirely new research program, involving new concepts, is created, whose domain of data overlaps areas traditionally assigned to religion and science.

These four structures are possibilities for building interactions between theology and science that are legitimate from the point of view of the scientific language game. In short, a theology-and-science proposal that fits one of these four descriptions is *scientific*, according to Lakatos's theory of science. But I stress that it has not thereby been shown to be an *acceptable* proposal unless it meets the criterion of empirical progress. No scientific reason has yet been given for choosing it over a scientific theory with no connections to theology.

These four types may not exhaust the possibilities for research programs in theology-and-science. However, in the following section I shall summarize three papers recently published in *Zygon*, showing that my four types are useful for interpreting existing work in the field.

Three Test Cases

RUSSELL ON ENTROPY AND EVIL. A great deal of the literature in theology-and-science begins with the suggestion of a correspondence of some sort between a term (or concept) from science and one from theology. At the beginning I mentioned a specific example from a paper by Peters. Also, both of the creation and cosmology arguments I mentioned there must begin by postulating a correspondence between the theological notion of creation and a scientific notion such as evolution or the big bang. Robert J. Russell argues in his paper entitled "Entropy and Evil" (1984) that the correct understanding of the relationship between these two terms—one from thermodynamics, one from religion and theology—is metaphorical.

Russell defines metaphor as an analogy between the normal context in which a word obtains its meaning and a novel context in which some new aspects of the concept are emphasized. Now, since this is analogy rather than identity, the relationship involves dissimilarity as well. This understanding of metaphor shapes Russell's presentation in that he begins with the obvious similarities between entropy and evil that warrant the metaphor but then proceeds to explore new aspects of each concept that are suggested by both the positive and negative analogies.

Russell hopes that "these observations will lend some justification for mixing the language of two separate fields of inquiry by showing the heuristic value of the metaphor" (Russell 1984, 457).

Two of the more obvious considerations upon which the metaphor is based are the traditional association in the Judeo-Christian tradition of evil with chaos, disorder, and dysfunction, and the fact that both evil in Christian thought and entropy in physics are dependent on "being," lacking independent existence. Based on this justification, Russell proceeds to derive from the metaphor conclusions relevant to both theology and physics. For example, Paul Tillich suggested that evil has an order, a "structure of destruction," but he never pursued the details of this structure. Russell proposes that this topic be pursued by considering the mathematical structure of entropy—the familiar bell curve—and seeing if it can be related to the problem of evil.

Considering implications for physics, Russell emphasizes the importance of the irreversibility of time for maintaining a sense of the reality of evil in Christian theology. Insofar as a correspondence is established between entropy and evil, the Christian who does not wish to deny the reality of evil has a stake in physical theories that maintain the irreversibility of time. Most physicists today opt for a dynamic world view that allows for complete reversibility of physical processes rather than for the irreversible thermodynamic view. Therefore, Russell is greatly interested in the recent work by Ilya Prigogine that gives new support to the view that temporal irreversibility is fundamental in nature (Prigogine 1984).

Russell's paper offers a fine example of the heuristic role of theology-and-science. By setting up a correspondence between a theological and a scientific term he has been able to show directions for further exploration in both fields. Notice that he has been careful not to suggest that there is a direct logical relation between entropy and evil or that the theological side of the equation supports Prigogine's conclusions—only that Christians have an interest in the results of this research. The implication is that those in a position to do so would be well advised to pursue this new modification of the thermodynamic research program in the hope of finding further scientific corroboration.

MASANI ON SIN IN PHYSICS AND ANTHROPOLOGY. In "The Thermodynamic and Phylogenetic Foundations of Human Wickedness" (1985) P.R. Masani provides examples of both the second and third types of theology-and-science sketched above. He suggests that a definition of sin could be included as an auxiliary hypothesis in a physics program so that (with the addition of other, as yet unavailable auxiliary

hypotheses) the sinfulness of humankind could be deduced. The same definition functions as the hard core of an anthropological research program.

Sin in thermodynamics. Masani sets out to *explicate* the concepts referred to by the words *evil*, *wickedness*, and *the fall* in scientific terms. *Explication*, as Masani uses it, means the transformation of an inexact concept into a more exact one, which can be substituted in most contexts and is fruitful in terms of allowing for simplicity in theorizing. He finds that this cluster of religious concepts cannot be explicated by a single new term and therefore distinguishes two senses of the fall. *Fall I* represents the incongruity between the actual state of affairs determined by the second law of thermodynamics, wherein the survival of any creature inexorably brings about the destruction of other creatures, and an imaginable state, preferable from a moral point of view, where survivability is not linked with destructiveness. Masani refrains from equating Fall I and its effects with evil.

Masani defines sinfulness of a species as follows. A species is sinful if, first, intraspecific killing is common (i.e., killing members of one's own species); second, intraspecific exploitation is common (exploitation is defined as acquiring unneeded food, shelter, etc., from a subset of the species); and, third, deceptive or dishonest intraspecific communication is common. With this definition of sin, the statement that humankind is sinful is observably true, just as it is observably false that other mammalian species are sinful. He defines *Fall II* as the temporal event in the course of evolution when species-oriented hominids evolved into ego-oriented humans.

Masani claims that the ultimate goal of his explication of sin and the fall is to embed the definitions in physics (in our terminology, to add them to the belt of auxiliary hypotheses of a research program in physics) and thereby allow the general law "humankind is sinful" to be deduced from the scientific premises. Two missing auxiliary links, however, are a direct correlation between macro- and micro-thermodynamics, and a direct correlation between overt individual behavior and sinfulness.[2] Despite the fact that Masani is aware of major difficulties, he has made the first steps toward the incorporation of a theological auxiliary hypothesis into a scientific research program.

Sin in anthropology. Masani reasons that because humankind is sinful according to the definition above, whereas earlier primates were not, it should be possible to locate Fall II in the course of the descent of Homo sapiens from its ancestors. The use of weapons and hunting tactics by Homo erectus suggests that, if not sinful, they were moving in that direction. There is clear evidence of intraspecific killing among

Homo neanderthalis—cracked skulls, battle axes, combat injuries, and drawings of battle scenes. Thus he locates Fall II around 100,000 years ago.

Masani considers and rejects two lines of argument contrary to his thesis. One is that other mammals exhibit intraspecific killing, suggesting that his definition of sin is not adequate to distinguish between humans and animals. He replies to this by providing evidence that intraspecific killing among animals is associated with human interference. The second line of argument comes from the "Neo-Rousseauists" such as Marxists who claim that human wickedness has a social rather than a phylogenetic origin, coming only with the advent of animal husbandry and agriculture about 10,000 years ago. In response he recalls the evidence of earlier violence mentioned above and adds evidence of violence and other kinds of sin among hunting and gathering peoples of today.

Masani concludes that the ancient religious view of the deepseatedness of human sinfulness, far from being mere superstition, is profoundly true.

In this second half of Masani's paper we see the outlines of an exciting scientific research program with a religious hard core. We might express the core, taken from religious discourse, as follows: "Humankind fell into sin at the beginning of its history." This core is elaborated by means of a set of auxiliary hypotheses that include the definitions of sin and Fall II above, as well as a number of methodological assumptions involved in the interpretation of the data and theories of instrumentation (for example, the theories behind the various dating methods). The data include primitive tools, bone fragments, drawings, and so on, as mentioned above.

Masani is also aware of competing research programs, and in the course of his paper makes a theoretical modification intended to account for some of the counterevidence used by the Marxists. Specifically, he distinguishes between actual sin and the propensity to sin (a distinction very much in keeping with Christian theology, I might add) and proposes a corresponding distinction between Fall IIa and Fall IIb. The former took place around 100,000 years ago and refers to the widespread propensity to sin, whereas the latter occurred around 10,000 years ago and reflects the greatly increased sins of violence associated with the rie of a socioeconomic order. This modification in the belt of auxiliary hypotheses to account for counterevidence used by a competing research program is exactly in keeping with Lakatos's description of the development of research programs.

Recall now Lakatos's criterion for the evaluation of research programs. He claims that programs are to be accepted if theoretical mod-

ifications (such as Masani's) are empirically progressive. That is, does the modification serve only to account for the anomaly for which it was made (in which case it is *ad hoc*) or does it also allow for prediction and corroboration of some novel fact? Masani made his modification in response to the anomalous observation that (some) hunting and gathering societies even today are peaceful, whereas those with a socio-economic class system are not. Unfortunately he does not suggest any independent (novel) corroboration of the new auxiliary hypothesis. What remains, then (and I see no reason why it could not be done) is to derive testable predictions from Masani's distinction between Falls IIa and IIb and thus make this a progressive research program.

Recall that Lakatos distinguished between mature and immature science on the basis of whether the modifications in the auxiliary hypotheses were made at random or in accordance with a unified plan. The fact that Masani's distinction between actual sin and the propensity to sin accords well with some strands of Christian thought suggests that his program could go forward under the guidance of a positive heuristic that directs researchers to make only modifications that are sanctioned by Christian theology.

On the basis of my evaluations I conclude that Masani has provided a very promising basis for a mature and progressive scientific research program with a religious hard core.

In distinction from the heuristic use of theology in science, research programs such as Masani's provide clear justification for logical relations between scientific and theological propositions. In this case a theological assertion has not merely suggested a scientific theory; it has *become* a scientific theory and forms part of a deductive argument whose premises are theories and whose conclusions are the evidence upon which the theory as a whole is based. The new use of the (originally) theological language is justified by the fact that the theory as a whole constitutes a contribution to scientific knowledge.

BURHOE'S HYBRID PROGRAM. I end this section with brief mention of an example of my fourth type of theology-and-science, that of a research program composed of concepts and theories not readily classifiable as either traditional religion or science. I believe that this type is the most useful for understanding the work of Ralph W. Burhoe. Burhoe has produced a massive system of thought, far beyond my ability to summarize here, so I mention but one article as representative of the thrust of his work. In "The Concepts of God and Soul in a Scientific View of Human Purpose" (1973) Burhoe describes the one and only ultimate reality, the lawgiver, partially revealed and partially hidden, who is the gracious source of hope and continuing creation. This one

reality is known in traditional religions as God, but known in contemporary science as the total cosmic ecosystem.

As a tentative suggestion I propose that the hard core of Burhoe's program is the thesis that a religion adapted to scientific culture is necessary in order for the human race to survive. This core is neither strictly scientific nor religious; since it is about science and religion it might be said to be metascientific and metatheological. However it is elaborated and related to its data by means of auxiliary hypotheses from a number of disciplines: evolutionary biology, behavioral psychology, genetics, and theology, among others. Explications of the one religio-scientific reality serve as auxiliary hypotheses supporting Burhoe's core.[3] They allow for the construction of arguments such as the following:

> The evolutionary process requires learning the laws of the cosmos.
> But "cosmos" and "God" are two names for the one reality.
> Therefore the evolutionary process requires learning the laws of God.

Evaluation of Burhoe's hybrid research program using Lakatos's criteria is not possible here, but it would be an interesting task. Perhaps the most difficult aspect would be to determine the appropriate competing research programs against which it could justly be compared.

Conclusion

The question at issue here is whether theology-and-science is meaningful, given that it proceeds apart from the established language games of both science and theology, for Wittgenstein and others lead us to believe that it is just these established contexts that give meaning to our discourse. I have recast this question by asking whether there exist rules in theology or science not only for use of current language but also for guiding new developments in linguistic practice and, if so, whether work in theology-and-science might be covered by these rules. I then provided a theory of scientific method that specifies conditions for accepting new theories or modifications of old theories, and I suggested ways that theology-and-science might meet such conditions. I have shown that Lakatos's criteria could be used to validate the use of theology as a heuristic tool in science, as auxiliary hypotheses or hard cores in scientific research programs, and as component parts of hybrid programs.

Thus, I suggest that possibilities are plentiful for meaningful cross-fertilization between science and theology, but in all cases acceptability of the proposals is conditional upon their measuring up to our best current standards for scientific (or theological) growth. Without solid confirmation in the form of new discoveries, theology-and-science

proposals remain just that—proposals. They are not meaningless, for they are proposals for new ways of using language. However, linguistic changes cannot profitably be accepted at random; we must show that they offer benefits in terms of increased knowledge. Thus, they must be seen as proposals for research, not proposals for faith.

NOTES

1. I believe the most serious criticisms revolve around three issues: first, the definition of novel facts (see Lakatos & Zahar 1975; Musgrave 1974; and Gardner 1982); second, the cogency of Lakatos's claim that his theory of science plays a double role both as a methodology and as a tool for the rational reconstruction of science—that is, that it is both normative and descriptive (see Kulka 1977; and Suppe 1977, 659-70); and, third, Feyerabend's claim that without a time limit for the evaluation of programs Lakatos's criteria are vacuous (see Feyerabend 1970).

2. Another difficulty here is that Masani has *moralized* sin, neglecting the important characteristic of sin's relationship to God. He has perhaps provided an adequate explication of wickedness, but not of sin.

3. I am indebted to David Breed for discussions of Burhoe's work that have suggested ways of construing it as a research program.

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