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SCIENTIFIC REVOLUTION: AN ANALYSIS AND EVALUATION OF THOMAS KUHN'S CONCEPT OF PARADIGM AND PARADIGM CHANGE FOR THEOLOGY

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In the opinion of both supporters and detractors of Thomas S. Kuhn's major work *"The Structure of Scientific Revolutions,"*¹ his ideas have had "a wider academic influence than any other single book of the last twenty years."² Langdon Gilkey compares the impact of Kuhn's work to that of Marx who "once shifted our understanding of historical development and possibly Gould [who] will do the same for biological evolution."³ Kuhn's concepts and ideas have been accepted readily not only in philosophy but also in the social sciences, the humanities and recently even in theology.⁴ There seems to be a trend to accept and incorporate Kuhn's ideas into theology.⁵ One of the chief characteristics of Kuhn's work can be seen in his epistemology and the recent change in the way epistemology is done.⁶ This can be noted in the way he interprets the authority of science, especially the process whereby scientific theories change.⁷ Because, according to Gutting, "science is the only generally recognized cognitive authority in the world today,"⁸ Kuhn's approach is significant in that he proposes a new interpretation of this authority. Kuhn himself is convinced that his ideas

could produce a decisive transformation in the present image of science.⁹

What was this image of science¹⁰ that Kuhn was about to change? How are models or theories constructed—in science as well as in (systematic) theology? How are we to understand the way in which science works and progresses? Kuhn set out to answer these questions with his “paradigm” concept. In order to better grasp the novelty of his thought and some of its implications for theology, we will look first at some characteristics of the “traditional image of science” that Kuhn was about to change and then contrast this with Kuhn’s alternative concept. Then we will point out some implications of Kuhn’s position. In doing this we limit ourselves mainly to Kuhn’s major work, *The Structures of Scientific Revolution*.

Traditional Science

For the past three centuries one scientific concept has exercised a pervasive influence on the world’s thinking, as can be seen in the popular beliefs about science. Many people for example view science as providing an objective knowledge that is based exclusively on “facts”.¹¹ It is supposed that from data of recorded observations and experimental measurements, scientific propositions and mathematical laws of nature can be deduced in a truly impersonal and detached way by a set of explicit rules. This empirical tradition in science can be traced back to Sir Francis Bacon (1561-1626). He assumed that science studied the real world. For Bacon

Science did not just study “phenomena” in a Kantian sense; it did not just observe a world order derived from the categories of the human mind already read into it in the act of perception. The world was “out there,” and scientists had the task of discovering its laws.¹²

The steps that Bacon laid out to discover these laws became to be known as the scientific method. It is characterized by first, gathering data; second, formulating a general rule that accounts for the data; third, deriving predictions from the hypothesis; fourth, checking the predictions by making experiments; fifth, if the predictions prove true, the hypothesis is given the status of a (tentative) law that is subject to further testing; sixth, if the

predictions proves false, one returns to step one and attempts to derive another hypothesis.¹³ According to Poythress, the underlying assumptions of Bacon's method were that data are hard facts, about which there is and can be no dispute. Hypotheses, in turn, arise from seeing a pattern in the data and making an inductive generalization. Predictions from a hypothesis are derived by simple deduction from the hypothesis itself. Discarding or retaining a hypothesis depends merely on whether the additional experimental data support it. Finally, confirmed hypotheses are added to the existing list of general laws. Thus, progress in science consists in piecemeal additions to the list of known laws.¹⁴ Ian Hacking¹⁵ has pointed out that the scientific model, Kuhn was about to change included a combination of several aspects. These will be referred to briefly below.

Realism. Science is an attempt to discover what is real in the world. Truths about this world are true regardless of what people think. Observations and experiments provide the foundations for hypotheses and theories about the real world "out there".¹⁶

Demarcation. There is a sharp distinction between scientific theories and subjective beliefs. In other words, one has to distinguish the psychological or social circumstances in which a discovery is made from the logical basis for justifying belief in the facts that have been discovered.¹⁷ Karl Popper has said that the objectivity and rationality of progress in science is not due to the personal objectivity and rationality of the scientist.¹⁸ In other words, the non-rational intuitions through which scientists were sometimes inspired do not invalidate the objectivity, testability, and rationality of science as such.¹⁹ Furthermore, scientific concepts are rather precise and the terms used in science have a definite and fixed meaning.²⁰

Science is Cumulative. Connected with this rationalistic view of science is the view that science cannot really break with tradition. It preserves the success of its predecessors.²¹ Past observations, laws, and theories are seen as permanent additions to the scientific knowledge. The result is that science was assumed to be a record of the steady accumulation of objective knowledge about nature as it really is.²²

Inductive/Deductive Structure. The scientific basically has

two parts: the inductive and the deductive. In the inductive, the scientist gathers individual bits of hard data that are considered to be the indisputable basis for knowledge and generalizes it to hypotheses. In the deductive, the scientist derives predictions and general laws from these hypotheses. Each law summarizes a pattern found inductively in the data.²³ The theories and predictions that result are then tested in order to falsify or confirm them.²⁴

Although no single philosopher has proposed these points in this exact sequence, they form a useful collage of a widespread popular conception of science.²⁵

Kuhn's Alternative Concept of Science

Kuhn rejected the classic view of science, that is, the view associated with Bacon's scientific method. He sees a difference between two fundamental kinds of situations: "normal science" and "scientific revolutions."²⁶ In order for a field of investigation to be scientific it must mature.²⁷ When a community of investigators accepts a particular achievement as foundational, i.e. as supplying at least temporarily a standard set of phenomena to be considered and a method for their consideration it becomes "mature." After one particular school of interpretation succeeds in setting standards for all further research in the field, this new achievement inaugurates a period of "normal science,"²⁸ devoted to "puzzle-solving."²⁹ As long as scientists continue to solve the puzzles that they find, they go forward in a way that superficially resembles Bacon's inductive ideal.³⁰ Normal science aims at elucidation based on puzzle-solving, not surprise based on innovation.³¹ The question Kuhn must face in view of his characterization of normal science is: How does scientific change occur? Everything about normal science seems to be oriented toward preventing fundamental change in a field of inquiry.

Although normal science is conservative, from time to time the anomalies in some branch of knowledge get out of hand and there seems no way to cope with them. This creates a crisis that is characterized by an atmosphere of urgency to solve these anomalies.³² This crisis leads eventually to the next stage: the scientific revolution.³³ A revolution occurs when a scientific community abandons one time-honored way of regarding the world and of

pursuing science in favor of some other, usually incompatible, approach to its discipline.³⁴

The shift from one paradigm to another “cannot be made a step at a time, forced by logic and neutral experiments.”³⁵ Paradigms are terminated not by deliberation but by “a relative sudden and unstructured event like the gestalt switch.”³⁶ Consequently, a new paradigm prevails only when the older generation has been “converted” to it; or had died off and been replaced by a new generation.³⁷ In this conversion experiment “neither proof nor error is at issue.”³⁸ A paradigm shift, therefore, is thus “a highly subjective process.”³⁹ Revolution occurs because the old paradigm is increasingly unable to solve pressing anomalies and new paradigms present new ways of looking at things, which in turn create new problems for people to get on with. This leads us to the concept of “paradigm” in Kuhn.

Paradigms. Normal science is characterized by a paradigm. The concept of paradigm is basic in Kuhn’s history of science.⁴⁰ A clear and uniform understanding of this important term has been made difficult by the wide variety of usages of this term by Kuhn himself. Masterman, in looking through the first edition of Kuhn’s work isolated no less than twenty-one different uses of the term paradigm.⁴¹ Shapere has criticized Kuhn for

inflating the definition ‘paradigm’ until that term becomes so vague and ambiguous that it cannot easily be withheld, so general that it cannot easily be applied, so mysterious that it cannot help explain, and so misleading that it is a positive hinderance to the understanding of some central aspects of science.⁴²

In acknowledging the problems with his use of paradigm Kuhn attempted to clarify his intent in the “Postscript” to the second edition of the work we are discussing. He basically distinguishes between two different uses of paradigm. One is the sociological use, which “stands for the entire constellation of beliefs, values, techniques, and so on shared by the members of a given community.”⁴³ Then there is the paradigm as achievement, where it denotes “concrete puzzle-solutions” that provide models for further research.⁴⁴ However, in providing this double answer Kuhn is faced with a great problem. According to his definition a paradigm not

only defines a normal scientific community of investigation but at the same time a paradigm is identified as that which is shared by a community.⁴⁶ Which comes first, the paradigm or the community? Kuhn himself admits that "a Paradigm is what the members of a scientific community share, and, conversely, a scientific community consists of men who share a paradigm. Not all circularities are vicious . . . but this one is a source of real difficulties."⁴⁶ As a way out of this circularity Kuhn proposes a turn to sociological methods for identifying a community as a first step and way out of the circle.⁴⁷

Another point that should be noted is that observations are paradigm-dependent. For Kuhn there is no neutral observation language. Paradigms determine the way a scientist sees the world.⁴⁸ For him there is no theory-independent way to reconstruct phrases like "really there." Not only are observations paradigm dependent but criteria too. Competing paradigms offer differing judgments as to what sorts of solution are acceptable. There are no external standards on which to base a choice between paradigms, for standards are themselves products of paradigms.⁴⁹ One would need a "super-paradigm" to decide between different paradigms but in a debate among paradigms there are no objective criteria.⁵⁰ Because scientists with rival paradigms may gather quite dissimilar sorts of data, the features which are important for one may be incidental for the other. Rival paradigms solve different types of problems; they are incommensurable.

Incommensurability. If two paradigms can be compared to each other, at least in principle, in order to find out which is more rational or closer to the facts, they are commensurable. Kuhn, however, holds that rival paradigms are incommensurable.⁵¹ There is no neutral language that can serve as an objective criterion itself because language itself is learned under a paradigm. Thus, incommensurability limits the role of logical compelling arguments in scientific change. The result is that the debate over paradigm choice is not a logical argument. It is not "the sort of battle that can be resolved by proofs," and "change cannot be made a step at a time, forced by logic and natural experience."⁵² Paradigms are terminated, not by deliberation and interpretation, but by a relatively sudden and unstructured event.⁵³ Incommensurability has ceased

to be a logical affair, and conversion has become a purely psychological matter.⁶⁴ Incommensurability is a doctrine that puts Kuhn at odds with most of modern science.⁶⁵ We now turn to a last aspect that is connected with the above discussion—the non-cumulative character of science.

Noncumulative Science. Revolutionary science is clearly non-cumulative for Kuhn.⁶⁶ Since a new paradigm demands the destruction of a prior one “cumulative acquisition on unanticipated novelties proves to be an almost non-existent exception to the rule of scientific development.”⁶⁷ For Kuhn new theories are not additions to, but rather, replacements of those older laws and theories, replacements that constitute nothing less than scientific revolutions.⁶⁸

Evaluation

Thomas Kuhn’s thoughts have not gone unchallenged. Several areas have been strongly criticized. Here we will concentrate only on the major criticisms that have been leveled against Kuhn’s work, then we will try to point out some implications for contemporary theology where the ideas of Kuhn have been assimilated.⁶⁹

Kuhn’s Concept of Paradigm. Almost all commentators agree that Kuhn’s use of this concept is loose and variable.⁶⁰ Shapere insists that the distinction between paradigms and different articulations of a paradigm, and between scientific revolutions and normal science is at best a matter of degree.⁶¹ If paradigms actually determine the structure of the world, as Kuhn maintains, the existence of anomaly is itself difficult to understand.⁶²

In Kuhn’s own initial definition, paradigms are “universally recognized scientific achievements that *for a time* provide model problems and solutions to a community of practitioners.”⁶³ In other words, a paradigm by definition has only provisional character for a limited period of time. There is no such thing as a permanent, trans-historical or trans-cultural paradigm. According to van Huyssteen, Kuhn’s “vision does open up vital perspectives on the question of the origins of our traditional theological models,” because Kuhn offers “the possibility of evaluating the development of systematic-theological models in sociohistorical terms.”⁶⁴ In other words, theo-

logical reflection or systematic theology is always only a group-bound activity.⁶⁵

Kuhn's account of science fundamentally depends upon the distinction between normal science and revolutionary science. Apart from the difficulty in identifying when a change is a "revolution" and when it isn't, the sharp contrast between normal and revolutionary science has been questioned.⁶⁶ Differences between the two are differences of degree rather than of kind. There also is more continuity across a revolution than Kuhn depicts; there may be changes in such items as assumptions and instrumentation, but there are no total discontinuities.⁶⁷

In this context it should be mentioned that Kuhn's understanding of progress is derived explicitly from an etiological evolution logic⁶⁸ which is formulated in neo-Darwinian terms.⁶⁹ One consequence of this underlying premise is, as Johann Baptist Metz puts it, that such an evolutionary model does not "permit a normative use of history, let alone a 'canonical' one."⁷⁰ Consequently this makes relativism, at least to a certain degree, unavoidable, as we will see later.

Kuhn's Relativism. Probably more important than the criticisms just listed are charges that point to a relativism in Kuhn's thought. If observations as well as criteria are paradigm-dependent, there is no rational basis for choice among competing paradigms.⁷¹ Although some claim that Kuhn's strong emphasis on sociological, psychological, historical, and other factors in scientific revolutions does not mean a lapse into irrationality one has to realize that there is a new definition of rationality. Rational simply means "that on which a certain scientific community has decided jointly."⁷² Because each paradigm determines its own criteria, any argument for it is circular. The choice seems to be arbitrary and subjective, a matter of psychology more than of logic.⁷³ It is precisely on this point that Kuhn's critics are most vehement, accusing him of relativism, subjectivity, and irrationality.⁷⁴

Because relativism simply means that "truth" is to be determined according to the internal consistency of a paradigm,⁷⁵ epistemological relativism seems unavoidable.⁷⁶ In commenting on the influence of Kuhn's ideas in theology, Jerald Brauer says that one

of the main characteristics of modern Christianity is the massive presence of pluralism.⁷⁷

Kuhn has objected to the charge of irrationality.⁷⁸ Some of Kuhn's critics, however, are far from satisfied in this regard. Thus Shapere, in a review of Kuhn's recent writings, repeats his earlier concerns by saying that "it is a viewpoint as relativistic, as anti-rationalistic, as ever."⁷⁹

At this point an observation by Stephen Toulmin is worth our attention. Toulmin has pointed out that the reasons why Kuhn's book has been so influential lie less in the answers Kuhn has given to the fundamental questions about conceptual change in science than in the broader background of the questions.

By insisting on the radical character of scientific change, Kuhn completed the historicization of human thought that had begun in the eighteenth century, and so finally undercut the older views about the immutable order of nature and human knowledge. The task for those who are interested in the theological implications of contemporary natural science is, therefore, not to replace one static but outdated system of doctrine (paradigm) by another, equally static but more up-to-date system: instead, it is to carry further the work of Troeltsch and those other theologians who have reflected on the specific relevance of Historicismus to the projects of theology and cosmology.⁸⁰

Troeltsch has given the principles of historical criticism a classical formulation.⁸¹ In an earlier essay on history and metaphysics, he declared that the historical-critical method, once it gains entrance, brooks no limits. Developed to deal with natural events, it is bound, if applied to the supernatural, to dissolve it into the natural and to interpret it as analogous to everything else.⁸² This, clearly, sounds like a promising candidate for the title "paradigm change" in theology.⁸³ Indeed, many leading scholars, like David Tracy, have stated that "the acceptance and use of historical-critical methods is one defining characteristic of the new paradigm in theology."⁸⁴ As Toulmin has stated it: "If a supra-historical standpoint from which we could definitively judge is not available to human beings, a structuring must take place immanently and relatively."⁸⁵ One consequence for theology is that the Christian identity of meaning cannot be found in the Bible.⁸⁶ In addition, another aspect of Kuhn's position deserves attention, namely, what

has been called Kuhn's psychologism.⁸⁷ Psychologism states that a text's meaning cannot be the same for two different people because they look at the text from different subjective standpoints. The historicist position proposes the same argument *a fortiori* for interpreters and authors who stand at different cultural times and spaces. The implication of these views is obvious. A text does not have a fixed meaning, determined by the original author, that serves as an objective set of facts by which various interpretations are measured. Rather, the meaning of the text is determined by the interpreter. The subject—object distinction is not regarded as fixed, and the question of objective validity in interpretation is ruled out.⁸⁸

Kuhn also has been charged with inconsistency in his reasoning. Holcomb has reasoned that Kuhn's notion that all criteria are paradigm-dependent is "self-referentially inconsistent."⁸⁹ If the truth of Kuhn's relativistic thesis is paradigm-laden, by previous argumentation, it has no force for anyone who has not yet accepted it. A result would be that Kuhn cannot talk about the "history of science," but only about the history of science as conceived in his paradigm.⁹⁰ This suggestion has the crucial consequence of shifting the focus from objectivity "to the real issue, namely truth."⁹¹

The Question of Truth. For Kuhn there are no external, paradigm-independent standards that determine whether the paradigm in question is true or false. Ian Barbour views this question of criteria for paradigm choice as the most important issue in the controversy over Kuhn's book.⁹² Kuhn clearly denies that we can get closer to the truth by means of new and changing paradigms.⁹³ He states that "whatever scientific progress may be, we must account for it by examining the nature of the scientific group, discovering what it values, what it tolerates, and what it disdains."⁹⁴ Kuhn rejects what he calls "objective" or "absolute" truth in favor of a pragmatic or instrumental view of truth.⁹⁵ "As in political revolutions, so in paradigm choice—there is no standard higher than the assent of the relevant community."⁹⁶ Truth no longer corresponds to nature but to what humans accept; in other words, it is sociologically defined.⁹⁷ For theology, this means that religious doctrines can be outlined only provisionally⁹⁸ because they arise neither from revelation nor as an attempt to describe the real

external world. They originate rather in the desires of men to find suitable instruments with which to bring about certain desirable results. In other words, there are no absolutely true doctrines because all ideas are tools subject to improvement. Because doctrines are based on experience, they will change as experience changes.

Consequently unity in theology will not be a unity of a particular interpretation which results in a particular teaching, that is, no unity in doctrine, but it will be a unity in sensing the common need of interpreting our present world of experience in all its ambivalence, contingency, and change.⁹⁹ In this context Sally McFague has said that “we are, then, on the brink of another ‘reformation.’”¹⁰⁰ Indeed we are! Kuhn’s use of the concept of paradigm and paradigm-change amounts to nothing else but the old fallacy that man is the measure of all things.

Conclusion

Kuhn has proposed a new interpretation of science. From the positive standpoint it should be noted that we have to give Kuhn credit for having broken new ground in the philosophy of science. He has done much to call into question “the fundamental self-understanding of modernity with its illusory dichotomy between science and ideology.”¹⁰¹ He has done a significant job in demythologizing much of the absolute nature of science that has dominated the scholarly world for so long. Science is now being perceived more as a “human activity” and the contrast between so-called objective truth and metaphysics is being considered as obsolete.¹⁰² Also, his insight that scientific theories cannot be overthrown by experiments and observation alone merits serious attention.

In contrast to the longstanding empirical tradition, which assumed that science studies the real world through objective, logical experiments and observations that are based on indisputable facts; Kuhn maintains that it is impossible to find out anything about the real world because there is no paradigm-independent way to reconstruct it. Data never are simply hard facts that are completely independent from any theory. The lack of an overarching framework that gives guidance makes the scientific community the

ultimate authority in science. Truth no longer corresponds to reality but to what humans accept. Ideas become true insofar as they help us to make successful connections between various parts of our experience. Truth becomes part of the process of experience and, because experience constantly changes, truth does to. In other words, for Kuhn there are many plural truths, as many truths as there are concrete successful actions. Truth becomes pragmatic in the sense that that which works is accepted as truth. An authoritative revelation from God to man that retains its meaning and authority beyond changing times and cultures virtually is excluded from a paradigm in the Kuhnian sense. The unity of the church consequently is no longer a unity of teaching that results from revealed truth but is merely a unity that is accepted in its search for new approaches in the changing sea of ambiguous meaning.

Let me conclude with a word of caution in regard to the use of Kuhn's notion of paradigm, especially when it is too carelessly translated into other fields of study, such as theology. Even well-known theologian Eberhard Jüngel does "not consider it [the concept of paradigm] to be so helpful that theology is bound to adopt this terminology. It probably confuses more than it clarifies."¹⁰³ No one knows where the philosophy of science is going next. It has been said that the one who marries current science is destined to be a widower soon.¹⁰⁴ Noted scholar Stephen Toulmin has said that

the call for 'new paradigms' in theology should not ask us to assemble the more up-to-date scientific ideas of post-Darwin, post-Einstein, post-Freud era into a novel cosmological construction that claims the same fundamental authority and permanence that were claimed for Aristotle and Newton earlier. That will simply lay up fresh trouble for theology a century or two down the road, when scientists have rethought the problems of their own disciplines, to the point of making radical changes for which theologians would once again be ill prepared. It may well be the case, indeed, that theology can hope for no secure and permanent reliable foothold in the natural sciences.¹⁰⁵

For us it is a matter of intellectual responsibility to understand the scientific theories of philosophy on their own terms. Otherwise, as Cordell Strug has put it, the theologian who refers to "paradigms, models, and things like that" to justify his beliefs is no better

than the undergraduate who refers to "Freud, existentialism, Zen and stuff like that" to justify his.¹⁰⁶ In addition there is a danger that the thesis will contain elements, unnoticed in its original context, that will question the possibility of theology just as much as older theories did.¹⁰⁷ Therefore, it is not wise to adopt Kuhn's thesis of paradigm change for use in SDA theology. Instead we are safe only in working out principles that are derived solely from Scripture and are in harmony with, and not in contradiction to, God's everlasting Word.

Endnotes

¹ Thomas S. Kuhn, *The Structure of Scientific Revolutions*, second edition (Chicago: University of Chicago Press, 1970).

² Gary Gutting, ed. *Paradigms & Revolutions. Applications and Appraisals of Thomas Kuhn's Philosophy of Science* (Notre Dame: University of Notre Dame, 1980), p. v. Even critics of Kuhn's work acknowledge that "it is bound to exert a very wide influence among philosophers and historians of science alike." Cf. Dudley Shapere, "The Structure of Scientific Revolutions," in *Paradigms & Revolutions*, ed. Gary Gutting, p. 27. Frederick Suppe, on the other hand, labels the position shared by Kuhn and others "passe." Cf. Frederick Suppe, *The Structure of Scientific Theories* (Urbana: University of Illinois Press, 1977), p. 633.

³ Langdon Gilkey, "The Paradigm Shift in Theology," *Paradigm Change in Theology*, ed. by Hans Küng and David Tracy, transl. by Margaret Köhl (New York: Crossroad, 1989), p. 367.

⁴ Kuhn himself is convinced that his theses "are undoubtedly of wide applicability." *SSR*, 208. Two representatives from different theological camps may show the influence of Kuhn's thought in recent theology. Cf. Hans Küng, *Theology for the Third Millennium. An Ecumenical View*, trans. by Peter Heinegg (New York: Doubleday, 1988), pp. 123-169; Vern S. Poythress, *Science and Hermeneutics. Implications of Scientific Method for Biblical Interpretation* (Grand Rapids, MI: Zondervan, 1988), pp. 32-102. Cf. also the discussion in Hans Küng and David Tracy, eds. *Paradigm Change in Theology*, transl. by Margaret Köhl (New York: Crossroad, 1989). Rüdiger Bubner claims that Kuhn's ideas have been greeted with lively assent in German philosophy. Rüdiger Bubner, "Paradigm Change: Some Continental Perspectives," in *Paradigm Change in Theology*, p. 242.

⁵ Recently Wentzel van Huysteen has said that in his view Kuhn's ideas have "created a basis for a new, alternative, conceptual model in theology." Wentzel van Huysteen, *Theology and the Justification of Faith. Constructing Theories in Systematic Theology*, transl. by H. F. Snijders (Grand Rapids: Eerdmans, 1989), p. 61. But see also the extensive review article by John S. Feinberg: "Rationality, Objectivity, and Doing Theology: Review and Critique of Wentzel Van Huysteen's Theology and the Justification of Faith," *Trinity Journal* 10/2 (1989): 161-184.

⁶ This seems to be one of the major concerns of Kuhn himself. In one place

he says: "I really want to know what sort of thing knowledge is, what it is all about, and why it is that it works the way it does." Quoted in Ian Hacking, review of *The Essential Tension*, by Thomas S. Kuhn, in *History and Theory* 13 (1979): 224. Cf. also J. P. Moreland, "Kuhn's Epistemology: A Paradigm Afloat," *Bulletin of the Evangelical Philosophical Society* 4 (1981): 33.

⁷ Steven T. Ostovich, "History, Theology, and the Philosophy of Science," (Ph.D. dissertation, Marquette University Graduate School, Milwaukee, 1986), p. 150.

⁸ Gutting, p. 1. On the definition of science and some popular misconceptions of science see also the discussion in J. P. Moreland, *Christianity and the Nature of Science. A Philosophical Investigation* (Grand Rapids: Baker Book House, 1989), pp. 17-42.

⁹ Kuhn, *SSR*, p. 1.

¹⁰ In this paper, the word science generally refers to natural sciences, not social sciences.

¹¹ Moreland lists several characteristics of what science is believed to be. J. P. Moreland, *Christianity and the Nature of Science*, pp. 23-42.

¹² Poythress, p. 32.

¹³ *Ibid.*, pp. 32, 33. Cf. also Hilary Putnam, "The 'Corroboration' of Theories," in *Scientific Revolutions*, ed. by Ian Hacking (Oxford: Oxford University Press, 1981), p. 63. This conception of scientific method was further formulated, refined, and set in the context of a comprehensive philosophical viewpoint by the school of logical positivism, beginning in the early twentieth century. See Del Ratzsch, *Philosophy of Science* (Downers Grove, Ill: InterVarsity Press, 1986), pp. 21-39. For our purposes, however, we may ignore variations in conception and concentrate on common features.

¹⁴ Poythress, pp. 35, 36. Charles Hodge may be seen as a representative theologian who has employed this scientific method in doing theology. For him the individual texts of the Bible are the data which the theologian/scientist uses inductively to formulate principles in the form of general doctrinal truths which are in turn checked for their consistency with the whole Bible. Cf. Charles Hodge, *Systematic Theology*, 3 vols. (Grand Rapids, MI: Eerdmans, 1970), 1:9-17.

¹⁵ Ian Hacking, ed. *Scientific Revolutions* (Oxford: Oxford University Press, 1981), pp. 1-5.

¹⁶ *Ibid.*, p. 1.

¹⁷ *Ibid.*, pp. 1, 2.

¹⁸ Karl Popper, "The Rationality of Scientific Revolutions," in *Scientific Revolutions*, ed. by Ian Hacking (Oxford: Oxford University Press, 1981), p. 95.

¹⁹ Cf. *Ibid.*

²⁰ Hacking, 2.

²¹ Popper, *Rationality*, p. 95.

²² Ostovich, p. 158; see also Israel Scheffler, *Science and Subjectivity* (Indianapolis: Bobbs-Merrill, 1967), p. 9. Cf. Janet A. Kourany, "The Nonhistorical Basis of Kuhn's Theory of Science," *Nature and System* 1 (1979): 47.

²³ Cf. Poythress, 36, Hacking, 1.

²⁴ Cf. Putnam, p. 74.

²⁵ *Ibid.*

²⁶ Actually Kuhn mentions three kinds of situations in the development of a particular scientific field. We have left out what he calls "immature science"

which is the first stage because the result under this condition is not considered science in the first place.

27 Thomas S. Kuhn, "Reflections on my Critics," in *Criticism and the Growth of Knowledge*, ed. Imre Lakatos and Alan Musgrave (Cambridge: University Press, 1970), p. 245.

28 "Normal science' means research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice." Kuhn, *SSR*, p. 10.

29 *Ibid.*, pp. 35-42. Kuhn also calls this activity "mop up work." *Ibid.*, p. 24.

30 Poythress, pp. 46, 47.

31 Puzzles in normal science are tests not of the system of explanation but of the skill and ingenuity of the scientist; failure to solve a problem is blamed on the scientist, not on the system. Kuhn, *SSR*, p. 80.

32 Cf. *Ibid.*, p. 91.

33 *Ibid.*, pp. 77-91.

34 Cf. *Ibid.*, pp. 89-91.

35 Kuhn, *SSR*, 150.

36 *Ibid.*, pp. 122, 150. A Gestalt is a way of seeing, an observational grid, a perceptual approach or perspective. Thus a paradigm change involves replacing one way of seeing the world with another. This shift from one perspective to another does not occur gradually by the accumulation of more perceptual information but all at once. Cf. Moreland, *Christianity and the Nature of Science*, pp. 200, 201.

37 On conversion as a feature of revolutions in science see: I. Bernard Cohen, *Revolution in Science* (Cambridge, Massachusetts: The Belknap Press of Harvard University Press, 1985), pp. 467-472.

38 Kuhn, *SSR*, pp. 151, 204, 4, 5.

39 Cf. Ian Barbour, "Paradigms in Science and Religion," in *Paradigms & Revolutions*, ed. Gary Gutting, p. 225.

40 Dudley Shapere, *The Structure of Scientific Revolutions*, p. 27.

41 Margaret Masterman, "The Nature of a Paradigm," in *Criticism and the Growth of Knowledge*, ed. Imre Lakatos and Alan Musgrave, pp. 59-89. See also Moreland, *Christianity and the Nature of Science*, pp. 195, 196.

42 Shapere, "Scientific Revolutions," 38.

43 Kuhn, *SSR*, p. 175.

44 *Ibid.*

45 Cf. Alan E. Musgrave, "Kuhn's Second Thoughts," in *Paradigms & Revolutions*, ed. Gary Gutting, 39-41.

46 Kuhn, *SSR*, p. 176.

47 *Ibid.*, 176-181.

48 *Ibid.*, p. 111.

49 Kuhn, *SSR*, p. 109.

50 Barbour, p. 225. "There are no external standards for settling a dispute because, in a revolution, the standards themselves change" (Ostovich, p. 177).

51 Kuhn, *SSR*, p. 103. Incommensurability means that they cannot even be compared to each other for rational assessment because nothing outside the paradigms can serve as common ground for such assessment. See Moreland, *Christianity and the Nature of Science*, p. 199.

52 Kuhn, *SSR*, pp. 148, 150.

53 *Ibid.*, p. 122.

54 Musgrave, p. 50.

55 Ostovich, p. 177.

56 Kuhn, *SSR*, p. 140.

57 *Ibid.*, p. 96; cf. p. 91.

58 Kourany, p. 49.

59 Matthew L. Lamb has pointed to this relationship when he says: "Many parallels could be drawn between developments in the philosophies of science and those in modern and contemporary theologies. . . . This process has many parallels in modern and contemporary developments within theology as these have attempted to cope with the fundamental import of . . . the interactions between Christian religious traditions and human experience."—Matthew L. Lamb, "The Dialectics of Theory and Praxis within Paradigm Analysis," in *Paradigm Change in Theology*, pp. 86, 87.

60 Cf. Masterman, pp. 61-66; Shapere, pp. 29, 38.

61 Shapere, p. 32.

62 Arthur J. Moen, "Paradigms, Language Games, and Religious Belief," *Christian Scholars Review*, 9 (1979): p. 21.

63 Kuhn, *SSR*, p. viii, italics supplied.

64 Van Huysteen, p. 62.

65 *Ibid.*

66 Barbour, pp. 226, 227. S. E. Toulmin finds frequent small changes more typical of science—"micro-revolutions"—that do not fit either of Kuhn's two classifications. Furthermore, he argues that the struggle of alternative views occurs not simply in rare crises but more or less continually. S. E. Toulmin, "Does the Distinction between Normal and Revolutionary Science Hold Water?" in *Criticism and the Growth of Knowledge*, ed. Imre Lakatos and Alan Musgrave, pp. 39-47. Cf. also J. W. N. Watson, "Against 'Normal Science,'" in *Ibid.*, pp. 25-37.

67 Barbour, p. 227. Cf. Shapere, p. 34. There are other criticisms leveled against Kuhn's concept of science that we have no time to go into here, but see Musgrave, p. 42; Karl Popper, "Normal Science and its Dangers," in *Criticism and the Growth of Knowledge*, ed. Imre Lakatos and Alan Musgrave, pp. 51-58; Paul Feyerabend, "Consolations for the Specialist," in *Ibid.*, pp. 197-230. Kourany has shown that even according to Kuhn's own sources several examples of alleged theory replacements, like Dalton's atomic theory, the theory of energy conservation, the role of the caloric theory and its replacement, etc. do not justify his claim. Cf. Kourany, pp. 50-52. Interestingly Kuhn has now abandoned the notion of paradigm in favor of the twin notions of "exemplar" and "disciplinary matrix." Cf. Kuhn, *SSR*, pp. 182, 187. How adequate that distinction is remains, however, "a subject of current debate." Suppe, p. 150.

68 This means that evolution aims at nothing except—evolution.

69 "The developmental process described in this essay has been a process of evolution from primitive beginnings . . . but nothing that has been or will be said makes it a process of evolution toward anything." Kuhn, *SSR*, pp. 170, 171.

70 Johann Baptist Metz, "Theology in the New Paradigm: Political Theology," in *Paradigm Change in Theology*, p. 355.

71 Moen, *Paradigms*, p. 21.

72 Van Huysteen, p. 61.

73 Cf. Imre Lakatos, "Methodology of Scientific Research Programs," in *Criticism and the Growth of Knowledge*, ed. Imre Lakatos and Alan Musgrave, pp.

93, 178. David Hull says that such a view "seems to require that the choice of one scientific theory over another entails an inferential leap which is at least beyond the power of current formulations of logic, if not inherently nonrational." David Hull, *Philosophy of Biological Science*, p. 11, as quoted in Moreland, *Kuhn's Epistemology*, p. 41.

74 Cf. Harmon R. Holcomb III, "Circularity and Inconsistency in Kuhn's Defense of His Rationality," *The Southern Journal of Philosophy* 25 (1987): 471.

75 Ian Barbour maintains that there is a "pragmatic element in Kuhn's thesis" where a proposition is true if it works in practice. Ian Barbour, *Religion in an Age of Science* (San Francisco: Harper and Row, 1990), p. 35.

76 Moen, *Paradigms*, p. 20.

77 Jerald Brauer, "A New Paradigm for Theology? Introductory Remarks," in *Paradigm Change in Theology*, pp. 206, 207. Scheffler describes Kuhn's approach in the following strong and perhaps somewhat unjustified words: "Reality is gone as an independent factor; each viewpoint creates its own reality. . . . But now see how far we have come from the standard view. Independent and public controls are no more, communication has failed, the common universe of things is a delusion, reality itself is made by the scientist rather than discovered by him. In place of a community of rational men following objective procedures in the pursuit of truth, we have a set of isolated monades, within each of which belief forms without systematic constraints."—Scheffler, p. 19. Despite some overreaction Scheffler is right in his observation that Kuhn seems to rule out truth as a criterion of scientific progress. Note that Scheffler explicitly mentions the search for truth. Cf. also Suppe, p. 151.

78 Kuhn, *SSR*, pp. 185, 199, 200.

79 Shapere, "The Paradigm Concept," *Science* 172 (1971): 708.

80 Stephen Toulmin, "The Historicization of Natural Science: Its Implications for Theology," in *Paradigm Change in Theology*, pp. 233, 234.

81 These are: the principle of criticism or methodological doubt, the principle of analogy, the principle of correlation. Ernst Troeltsch, "Über die historische und dogmatische Methode in der Theologie," in *Gesammelte Schriften*, vol. 2 (Tübingen: J. C. B. Mohr, 1913), pp. 729-753.

82 Ernst Troeltsch, "Geschichte und Metaphysik," *ZThK* 8 (1898): 5, 6, as quoted in Brian Gerrish, "From 'Dogmatik' to 'Glaubenslehre': A Paradigm Change in Modern Theology?" in *Paradigm Change in Theology*, p. 161.

83 See Brian Gerrish, p. 161.

84 David Tracy, "Hermeneutical Reflections in the New Paradigm," in *Paradigm Change in Theology*, p. 37. Cf. also Schubert M. Ogden, "Response to Josef Blank: Biblical Theology and Philosophy in the New Paradigm," in *Paradigm Change in Theology*, p. 294; and Edward Schillebeeckx, "The Role of History in What is Called the New Paradigm," in *Paradigm Change in Theology*, p. 312.

85 Toulmin, p. 249.

86 Schillebeeckx, p. 312. Paul Ricoeur has said that "we cannot take a fully-fledged theological paradigm from the canonical texts themselves, without a dialogue—which may be highly conflictual—between the theological concerns of our time and those of the biblical texts." Paul Ricoeur, "Response to Josef Blank," in *Paradigm Change in Theology*, p. 285.

87 Moreland, *Kuhn's Epistemology*, p. 48.

88 See Moreland, *Kuhn's Epistemology*, p. 48. In this connection the influential hermeneutical approach of Hans-Georg Gadamer with the concept of the

"fusion of the two horizons" should be mentioned, which has found wide entry in recent theology. On this cf. Frank M. Hasel, "Some Aspects of Hans-Georg Gadamer's Hermeneutical Approach," unpublished research paper, Andrews University, 1989.

89 Holcomb, p. 472.

90 Ibid., p. 475.

91 Jack W. Meiland, "Kuhn, Scheffler, and Objectivity in Science," *Philosophy of Science* 41 (1974): 179.

92 Barbour, 226.

93 "We . . . have to relinquish the notion, explicit or implicit, that changes of paradigm carry scientists and those who learn from them closer and closer to the truth." Kuhn, *SSR*, p. 170. In a similar fashion Küng proposes the way through pluralism to ever greater truth, rather than making one method, model or paradigm absolute. Hans Küng, "Paradigm Change in Theology: A Proposal for Discussion," in *Paradigm change in Theology*, p. 10.

94 Kuhn, "Reflections on My Critics," in *Criticism and the Growth of Knowledge*, edited by I. Lakatos and A. Musgrave (Cambridge: University Press, 1970), p. 238.

95 Moreland, *Kuhn's Epistemology*, p. 41.

96 Kuhn, *SSR*, p. 94.

97 Holcomb, pp. 470, 476.

98 Steven T. Ostovich, *Reason in History. Theology and Science as Community Activities* (Atlanta, Georgia: Scholars Press, 1990), pp. 240-242. Cf. also Huysteen, p. xviii: "One of the most significant and incisive shifts in modern systematic-theological thought must surely be the swing away from a type of theology in which seemingly immutable conceptual models cause theological statements to be seen as precise and true dogmatic propositions, toward a new sensitivity to the relational nature of the language of religious experience."

99 See David Tracy, pp. 55-58.

100 Sally McFague, "An Epilogue: The Christian Paradigm," in *Christian Theology. An Introduction to its Traditions and Tasks*, ed. by Peter C. Hodgson and Robert H. King (Philadelphia: Fortress Press, 1985), p. 378. Gary Gutting seems right on target when he states that "the real significance of Kuhn's work is that the ultimate locus of science's rational authority is the scientific community." Gutting, p. 11. Similarly on page 3: "This emphasis on the scientific community's judgment as the ultimate locus of science's rational authority is the most fundamental feature of his account of science."

101 Lamb, p. 65.

102 See Ariel A. Roth, "What is happening to the Philosophy of Science?" *Origins* 17/1 (1990): pp. 3-7.

103 Eberhard Jüngel, "Response to Josef Blank," in *Paradigm Change in Theology*, p. 297.

104 J. P. Moreland, *Scaling the Secular City. A Defense of Christianity* (Grand Rapids, Baker Book House, 1987), p. 196.

105 Toulmin, pp. 236, 237. Similarly Thomas F. Torrance: "Christian theology in the context of Scientific Revolution," in *Pluralisme et Oecumenisme en Recherches Theologiques* (Paris: Duculot, 1976), p. 301.

106 Cordell Strug, "Kuhn's Paradigm Thesis: A Two-Edged Sword for the Philosophy of Religion," *Religious Studies* 20 (1984): p. 269.

107 Strug, p. 269.