

Michael Polanyi and Thomas Kuhn: Priority and Credit

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*The article argues that Polanyi was a likely source of influence on the theory of science that Kuhn developed in his *The Structure of Scientific Revolutions* (1962). The striking similarity between Kuhn's idea of incommensurability and Polanyi's rendering of scientific controversy in *Personal Knowledge* is featured here, and is used to expose a tension between Polanyi's notions of scientific controversy and unfolding truth.*

Marty Moleski's topic of relationship between the ideas of Michael Polanyi and Thomas Kuhn boils down to a question about truth and the historical record. An important episode of intellectual history is involved: of all the scholarly books published in the last fifty years, few have had an influence to rival that of Kuhn's *The Structure of Scientific Revolutions* (1962, hereafter *Scientific Revolutions*).¹ Moleski's knowledge of the Polanyi archives is second to none, and reading his scholarly article, "Polanyi vs. Kuhn: Worldviews Apart," has enhanced my understanding of relations between Polanyi and Kuhn and their ideas. I had strongly suspected, and have argued in print,² that Kuhn borrowed ideas from Polanyi without acknowledging their source, but it never occurred to me that Polanyi had the same suspicion. In his published comments on Kuhn, as for example in his contribution to the Crombie volume,³ and in the "Background and Prospect" that he added to the second edition of *Science, Faith and Society*,⁴ I took Polanyi to be expressing the thought that Kuhn had *independently* arrived at positions similar to his own and that he was not at all displeased by the convergence. Moleski corrects this interpretation of Polanyi, showing that Polanyi questioned whether the convergence was coincidental and indeed, not to put too fine a point on it, wondered whether Kuhn had been intellectually dishonest in the matter.

What I want to do in the following comments is, influenced by Moleski's comparison of Kuhn and Polanyi, rethink their relationship in light of the available evidence. My hope is, as Moleski notes in his footnote 8, to write further on this topic, depending on whether the MIT Library accedes to my request for permission to reproduce Kuhn's significant letter to Professor W. Poteat of February 1967. I will proceed by reflecting on some leading questions. I begin with a wide-angle account of the interests of Polanyi and Kuhn by noting a few important differences and the many similarities in the ways in which they think about scientific research.

How Do Polanyi and Kuhn Envision Scientific Research?

A. Some Differences in Conception

The object of scientific research is, for Polanyi, to make new, true discoveries of aspects of nature, and discoveries, as he sees it, may overturn existing knowledge. For Kuhn, a sharp distinction has to be made between two kinds of science: "normal" and "extraordinary." Kuhn sees most scientific research ("normal science") as assuming, and extending, currently received knowledge which exists in the form of a "paradigm." Kuhn's paradigms in effect *present* normal scientists with "puzzles," whereas Polyanian scientists draw from

personal knowledge in order to *choose* problems. “In choosing a problem,” Polanyi argues, “the investigator takes a decision fraught with risks.”⁵ Compared with puzzle solving in Kuhnian normal science, making a Polanyian problem-solving discovery looks to be a less structured affair, calling for acumen and audacity on the part of the individual scientist. Further differences between Polanyi’s analysis of science and that of Kuhn will be dealt with below, particularly those bearing on the question of truth.

B. Resemblances in Outlook

The similarities between Kuhn’s thought in *Scientific Revolutions* (1962) and Polanyi’s thought particularly, but not only, in *Personal Knowledge* (1958) are many. Scientific research is conducted in a *community* (singular in Polanyi’s view, multiple in Kuhn), possessing a large measure of *autonomy*, with members reaching *consensus* – the condition of stable knowledge - on most topics in their work. Structure in the community and its members’ systematic engagement in scientific research are grounded in *tradition*. Research typically *assumes* rather than criticizes traditional belief. Much of the scientist’s knowledge of how to do research is *tacit*, having been acquired by observation and emulation of the master practitioners to whom students are apprenticed. The doctoral apprenticeship is a subordination of the mind of the student to *authority*. An important part of education in science consists in students “*working out concrete problems*” with the aim of acquiring the skill “of converting a language, which [the student] ... so far had assimilated only receptively, into an effective tool for handling new subjects”⁶ and solving further problems. There is no Method of Science (e.g., verificationism or falsificationism). Scientific research relies on maxims, knowledge of which is for the most part tacit. Psychological ideas of *Gestalt* and of Jean Piaget are useful in analyzing processes underlying science, as for example perception, learning and discovery. Scientific researchers *solve problems*, and research is conducted within *conceptual frameworks* that have been handed down through education. A conceptual framework in science includes a worldview, presuppositions, theory, vocabulary, concepts, ontology, facts, precepts, values, and standards. The scientist’s *observation* is conditioned by his framework. *Anomalies* arise in the course of research when scientists’ observations conflict with predictions that have been deduced from the laws and theories embedded in the framework. Scientists seldom look on anomalies as falsifications. A divorce exists between successive conceptual frameworks in science, Polanyi describing it as a “logical gap” and Kuhn as “incommensurability.” When scientists relinquish one framework of belief for another, they undergo a *conversion*. Complementary opposed forces of *conservation* and a drive for *originality* operate in science. Kuhn refers to the “essential tension” between “tradition and innovation” and Polanyi comments on the “purposive tension” between “commitment” to tradition on the one side, and innovation or “originality” on the other.⁷ Of criteria (“accuracy, simplicity ...”) of what constitutes valuable knowledge, Kuhn writes that their “effectiveness ... does not ... depend on their being sufficiently articulated to dictate” scientists’ choices; Polanyi writes similarly regarding “intrinsic interest,” depth (“systematic interest”), and “certainty and precision” (“accuracy”).⁸

Can so many similarities all be coincidental?

How Might Polanyi Have Contributed to Kuhn’s Theory?

A. Evidence Kuhn Knew Polanyi’s Work

The accumulated evidence strongly implies that Kuhn was acquainted, and perhaps conversant, with Polanyi’s view of science before he sent the text of *Scientific Revolutions* off to his publisher. I construe the elements of the case as follows.

(a) Kuhn was reading Polanyi by the early 1950s, with certain writings of Polanyi being included in J. B. Conant's "General Education and the History of Science" course at Harvard.⁹ A Junior Fellow at Harvard (1948-1951), Kuhn began lecturing in the history of science in 1951, and taught in Conant's course from 1951 to 1956 when he left to take up a position at Berkeley.¹⁰ Interestingly, one of Kuhn's teaching colleagues in Conant's course, Leonard K. Nash, later to be appointed to a chair of chemistry at Harvard, published a deeply thoughtful book on the theory of science, *The Nature of the Natural Sciences* (1963), a year after Kuhn's *Scientific Revolutions*. Whereas Kuhn included only a single fleeting reference to Polanyi's thought in the body of *Scientific Revolutions*, Nash cites Polanyi frequently (and usually approvingly) – more often, indeed, than he does virtually any other scholar.¹¹

(b) Kuhn heard Polanyi give a lecture at Palo Alto late in 1958. Moleski indicates that they may have discussed matters at this time.¹²

(c) The paper, "The Essential Tension," delivered by Kuhn at a conference in 1959, presents a number of ideas that are redolent of Polanyi.¹³

(d) As Kuhn acknowledges, he had read at least some of *Personal Knowledge* when he produced his paper for a conference at Oxford in July 1961.¹⁴

B. Kuhn's Theoretical Debts and His Awareness and Acknowledgement of Debts to Polanyi

Might Kuhn have been aware of similarities between his theory and that of Polanyi and, if so, did he draw his readers' attention to them? Might he have been aware that he was in Polanyi's *debt* for certain of his ideas and, if so, did he acknowledge this? These are difficult questions moving beyond the issue of Kuhn's familiarity with Polanyi's writing; they require careful examination of particular Kuhn texts. Kuhn was *aware* that his theory was similar to Polanyi's in at least one respect, and he pointed this out in his writings. However it is difficult to tell whether Kuhn realized or suspected that he might have been *indebted* to Polanyi for this similarity (and others). Through most of his career, Kuhn acknowledged no debt to Polanyi. Below I list and comment upon the Kuhn texts that lead me to these conclusions.

1959 conference paper, "The Essential Tension" (reprinted in Kuhn 1977)

Kuhn presents ideas that are reminiscent of ones in Polanyi's *Personal Knowledge* (and other writings of Polanyi), although Polanyi is not mentioned in the paper. Among the ideas are tacit knowledge, anomalies as ubiquitous in science, the role of authority in the training of the scientist, scientific community, scientific research as embedded in tradition.

Oxford conference of July, 1961 (Kuhn's paper "The Function of Dogma in Scientific Research," and Polanyi's "Commentary," published in Crombie 1963)

David Naugle paraphrases Kuhn as acknowledging in this text that "Michael Polanyi's ideas of 'personal knowledge' and the 'tacit dimension' led Kuhn to develop his celebrated doctrine of the paradigm."¹⁵ As Moleski rightly points out, Naugle has misread the relevant passage in Kuhn. Kuhn wrote that: "though I have only *recently* recognized it as such, Mr. Polanyi himself has provided the most extensive and developed discussion I know of the *aspect of science* which *led me to my*" idea of (and term) "paradigm." Kuhn's notion of paradigms is, in this instance, that of "the particular model achievements from which ... the members of a scientific specialty *learn* to practise their trade. This they do partly by precept and rule but at least equally by

the practice-problem-solving.”¹⁶ Kuhn suggests, as Moleski appreciates, that he *independently* lit upon an idea that resembled Polanyi’s idea of tacit knowledge, not that Polanyi’s presentation had led him to the discovery of paradigms as a part of science.¹⁷

The Structure of Scientific Revolutions, 1st edition, 1962, p. 44 n. and text

Here Polanyi is described by Kuhn as having “brilliantly developed a very similar theme” to Kuhn’s that “the existence of a paradigm need not even imply that any full set of rules exists.” Kuhn’s note cites chapters V and VI of *Personal Knowledge* as containing Polanyi’s “theme.” Again, tacit knowledge is the single idea that Kuhn says he shared with Polanyi without suggesting he obtained it from Polanyi.

In the “Preface” of *Scientific Revolutions* Kuhn acknowledges thinkers who helped him on the way: Stanley Cavell, James B. Conant, Paul K. Feyerabend, Ludwik Fleck, John L. Heilbron, Alexandre Koyré, A. O. Lovejoy, Anneliese Maier, Hélène Metzger, Emile Meyerson, Ernest Nagel, Leonard K. Nash, H. Pierre Noyes, Jean Piaget, W. V. O. Quine, Francis X. Sutton, Benjamin Lee Whorf, and Gestalt psychologists. Polanyi’s name does not appear in Kuhn’s “Preface.”¹⁸

“A Function for Thought Experiments” (1964) in *The Essential Tension*

Observing that for scientists to dwell on “anomalies when they are first confronted is to invite continual distraction,” Kuhn remarks in a footnote: “Much evidence on this point is to be found in Michael Polanyi, *Personal Knowledge* (Chicago, 1958), particularly chap. 9.”¹⁹ Again, the impression given by Kuhn is that he formed this view independently and then found that he shared it with Polanyi.

The Structure of Scientific Revolutions, 2nd edition, 1970, “Postscript,” p. 191

Besides the citation in the note in the body of the book (see above), Kuhn refers to “tacit knowledge” as Polanyi’s “useful phrase,”²⁰ including it in the title – “Tacit knowledge and Intuition” - of section four (pp. 191-198) of the “Postscript” of *Scientific Revolutions*.

The Structure of Scientific Revolutions, 3rd edition, 1996

The only difference between this and the second edition is the inclusion of an index (prepared by Peter J. Riggs). Notwithstanding that Polanyi is twice mentioned in the book (pp. 44 n. and 191), his name is not included in its Index.

“Discussion,” 1995, published in *The Road Since Structure* (2000)

Moleski reproduces pertinent passages from this text in his article. Kuhn shows himself to be confused and confusing on Polanyi and Polanyi’s thought.²¹ Kuhn recalled that when he heard Polanyi’s lecture at Palo Alto in 1961 he was still engaged in writing *Scientific Revolutions*. According to Kuhn, he enjoyed Polanyi’s lecture and it may have assisted him to form “the idea of paradigm.”²² Kuhn noted that Polanyi’s writing had formed a part of Conant’s course, and that he “liked it quite a lot . . . Polanyi” Kuhn recognized “was certainly an influence.”²³ Kuhn also recalled in this “Discussion” that, when writing *Scientific Revolutions*, he had glanced at the recently published *Personal Knowledge*, only to decide that he “must not read this book now” because it would force him “to go back to first principles and start over again” and he “wasn’t going to do that.”²⁴ There is a solecism in these recollections of Kuhn, for how could he have decided that Polanyi’s book would force him to return “to first principles and start over again” if, as he suggests, he had not studied its content. For all Kuhn knew, he might have found that Polanyi’s understanding of science was congenial to him, and a source of ideas that he would wish to use! Indeed, in this “Discussion,” Kuhn acknowledged that Polanyi was an

undoubted influence on his thinking, which is a debt that he had studiously refrained from acknowledging in the past. Moreover, whereas Kuhn now denied having studied *Personal Knowledge* while he wrote his *Scientific Revolutions*, we recall his comment in the note in *Scientific Revolutions* as showing that he was sufficiently *au fait* with the contents of Polanyi's book as to be able to praise the "brilliant" development of the concept of tacit knowledge in two of its chapters.

To What Extent Is Kuhn's Revolution Motif Comparable to Polanyi's Notion of Scientific Controversy?

It is illuminating to trace the development of Kuhn's ideas about scientific revolutions in connection with Polanyi's discussion of the role of conceptual frameworks, logical gaps and conversion in science. Below I outline that development.

Kuhn's Concept of Scientific Revolution in 1957 (*The Copernican Revolution*)

As Westman (1994) has pointed out, Kuhn suggests in his *Copernican Revolution* that facts "exist independently of concepts. Theories can organize facts, but they do not constitute observations or facts" and, rather than being destroyed by scientific revolutions, phenomena that have been observed are "simply reorganized using different concepts."²⁵ Kuhn himself suggests that once "phenomena" (observed facts) have been revealed in science, and scientists have established "order" in "fields of experience," these represent "*permanent*" accomplishments.²⁶ Science has been practiced as a "continuous tradition," enabling the successors of Newton "to explain the phenomena first elucidated by Newtonian concepts, just as Newton [could explain the] phenomena previously elucidated by Aristotle and Ptolemy." Whereas "phenomena" form "a cumulative class through the history of science," concepts and explanations are, according to Kuhn, "repeatedly destroyed and replaced."²⁷ This is a conservative view of scientific revolution compared to that which appears in Kuhn's *Scientific Revolutions*. It does not include the idea of conceptual mutation that Kuhn would designate from 1961 as "incommensurability."

Polanyi's Concepts of Framework, Logical Gap and Conversion

Polanyi began addressing these and related topics in the 1940s, in works that form tributaries that flow into his *Personal Knowledge*. He sees languages as infused with worldviews. The "interpretative framework" of science is embodied in, expressed through, and supported by the language of science, representing an "idiom of belief."²⁸ Very shortly after his Gifford Lectures, Polanyi cites, in a 1952 article in *British Journal for the Philosophy of Science* (3:11: 217-232 and later incorporated in *Personal Knowledge*) Zande witchcraft, Marxism, and psychoanalysis as further examples of interpretative frameworks. The worldview of science is implicit in the grammar and vocabulary of science.²⁹ Language shapes thought as well as being an instrument for expressing thought, claims Polanyi. The vocabulary itself he explains as a particular "theory of all the subjects" and their "recurrent features" that can be discussed in the language.³⁰ The language enables only certain questions to be asked. Answers that are given to these questions serve to confirm the worldview that the language embodies. According to Polanyi, frameworks of belief cannot be evaluated from within. Using a language to question the worldview that is embodied in the language gives rise to self-contradictions. Only when he has relinquished one language for another, can an agent critically assess the worldview of the first language.³¹

Scientific discovery can ignite controversy, in Polanyi's view. Discovery may alter not only the content of scientific knowledge but the values and the methods of science. In a scientific controversy, supporters of a new framework of belief strive to wrest value for it away from the established framework. Polanyi's examples of controversies in science include the Copernican versus the Ptolemaic frameworks, Pasteur's view of yeast in fermentation as a cellular living organism versus Wöhler, Liebig and Berzelius' viewing it as a chemical compound, Freud's psychoanalytic theory and the frameworks of its opponents, and van't Hoff's theory of optically active carbon compounds and its rejection by Kolbe in light of his anti-speculative view of chemistry.³²

In *Personal Knowledge* Polanyi argues that scientists are typically committed to the prevailing framework of belief, uncritically accepting orthodoxy. A Polyanian framework of belief in science is (as are frameworks of belief outside of science) able to explain most, but never all, of the phenomena in its field, adherents being prepared to set aside such phenomena as their framework is unable to explain ("anomalies") in the expectation that their framework will eventually be able to explain them or else to explain them away as illusory.³³

The framework undergoes a programmatic elaboration; its concepts are modified to accommodate objects that are unique in some of their details. Polanyi refers to this as the "tacit art" of denotation, citing Urey's alteration of the meaning of the term "isotope" to include deuterium in its denotation.³⁴ Anomalies can eventually put a question mark against a framework. Polanyi observes that scientists may be swayed by "the loose ends of current thought" to replace one framework with another, notwithstanding that the new framework may have anomalies of its own.³⁵

Polanyi may look on a major new discovery in science as a new framework of belief (or else as significantly altering an existing framework). Polanyi describes a new framework and an existing one as being separated from each other by a "logical gap." He means that reasoning and evidence that are produced in "one framework of interpretation" are valueless to adherents of the other framework. Advocates of the new framework are unlikely to receive a sympathetic hearing from the supporters of orthodoxy.³⁶ In effect, the orthodox are being asked to learn a new language, which they will refuse to do since they take the language to be meaningless.

The "logical gap" between conceptual frameworks involved in a controversy in science is, for Polanyi, analogous to the separation that exists between a problem in scientific research and the discovery by which it is solved. No rule of logic can lead an inquirer from his problem to its solution. The gap can only be crossed heuristically, by the inquirer leaping from the known to the unknown, his discovery being a feat of illuminative originality. For Polanyi, the logical gap means that the new framework has no logical relation (entailment, inclusion, contradiction, disjunction) with the established one.³⁷ The discovery irrevocably "changes the world as we see it. ...My eyes have become different; I have made myself into a person seeing and thinking differently."³⁸ Adherents of the new framework "think differently, speak a different language, live in a different world."³⁹

The scientist requires a conceptual framework as a condition of making "sense of experience" and each framework incorporates a unique view of reality.⁴⁰ Polanyi takes supporters of frameworks that are separated by a logical gap to live in the same "material universe," of which their frameworks give different pictures. Existing unformulated in the discoveries that scientists are mentally incubating at any time, premisses are fundamental to any framework in sustaining, while being affected by, methods, standards of quality, problems,

evidence, concepts, facts and relations that are taken by scientists to be credible and convincing, and by Polanyi as interdependent.⁴¹

In view of these differences between logically dissociated frameworks, Polanyi infers that supporters of one framework in science can never demonstrate their propositions to their opponents. “Assertion can be made only *within* a framework;” there being no vantage point that is external to, and independent of, any framework.⁴² Arguments from the premisses of one framework appear as “specious” to the opposition.⁴³ One side’s predictive successes are irrelevancies to those on the other side of a logical gap. There is no framework-independent position from which, or method by which, to adjudicate in a controversy between dissociated Polanyian frameworks. Choice between frameworks is never compelled by facts and arguments, being a *conversion* that is mostly actuated by “intellectual passions.”⁴⁴

Kuhn’s Position in 1962 (*The Structure of Scientific Revolutions* and its subsequent editions)

In each discipline of science, argues Kuhn in *Scientific Revolutions*, research is intermittently plunged into a crisis, disrupted, and then gets underway again in a reconstituted form. Scientific knowledge cannot accumulate long term under these conditions.⁴⁵ Acceptance of a new paradigm (*qua* theory/framework) is, for Kuhn, *at the expense* of one that has sustained research in a scientific community up to that time. Kuhn describes each paradigm as presenting a unique view of the world. Many of the paradigm/theory’s *names* are taken over from the past, but their meanings and “conceptual networks” are new, with the terms being applied to different objects or to old objects that have been ascribed with “new properties” and behaviour.⁴⁶ The paradigm poses new problems (“puzzles”) and issues new standards of solution. There are new methods, instruments, and “manipulative procedures,” while old instruments that continue in use are likely to “yield different concrete results,” manipulations and measurements from what they yielded in the past.⁴⁷

There is “a sense,” Kuhn believes, in which each paradigm in science is “constitutive of nature.” The sense is one in which scientists with a new paradigm “see the world ...differently,” respond “to a different world.”⁴⁸ Kuhn adds that while scientists in the aftermath of a scientific revolution continue to look “at the same” world they “*see* different things.”⁴⁹ In certain passages Kuhn suggests that a new paradigm changes the world from that with which its adherents used to deal as followers of the last paradigm, but this is Kuhn rhetorically exaggerating in order to get his point across. He gives a more measured statement of his view in affirming that “The world does not change with a change of paradigm, [but] the scientist afterward works in a different world.”⁵⁰ For Kuhn, the scientist does not apply his ideas to “raw sense data.”⁵¹ The data and observations are not fixed by the combination of the world and the scientist’s perceptual apparatus. Observations are not neutral in regard to paradigms and are not reinterpreted in light of paradigms.⁵² Perception and data are conditioned, Kuhn argues, by the physical world, perceptual apparatus *and* paradigm *together*.

Kuhn takes the effect of paradigm change on a scientist’s perception to be analogous to a gestalt experience – “same retinal impressions” while seeing “different things”⁵³ – with the difference that in science there is no “external authority” or “standard,” which for psychological experiments happens to be the “experimenter” who assures the subject that *this in fact is what* he has been “looking at.”⁵⁴ With a new paradigm, the scientist sees objects “differently from the way he had seen [them] before.”⁵⁵ There has occurred a “transformation” or “shift of vision” Kuhn considers, notwithstanding that the scientist who has lived through a scientific revolution continues to look “at the same world.”⁵⁶

As accounts of the world, Kuhnian paradigms are “incommensurable.” In various ways (e.g. disagreeing about theories and facts, “about what is a problem and what a solution,” about concepts and meanings, methods and standards), the dialogue between supporters of different paradigms is “slightly at cross-purposes” with them “talk[ing] through each other.”⁵⁷ Paradigm choice cannot be effected exclusively by “logic and experiment.”⁵⁸ Dramatizing the extent and depth of change involved when one incommensurable paradigm replaces another, Kuhn refers to the upheaval as a “scientific *revolution*.”

Did Kuhn Know of Polanyi’s Ideas about Frameworks, the Logical Gap, Controversy and Conversion?

Polanyi did not develop a theory of patterned scientific development in the way that Kuhn did with his thesis of eras of normal science ending in revolutionary upheavals. Polanyi’s purpose in explaining logical gaps and scientific controversies was to show that choice between frameworks in science is - contrary to those theorists who present science as simply “objective” - influenced by many deeply personal factors and these are components of whatever might be regarded as rational and empirical judgment. However, Polanyi’s ideas of logical gap, controversy and conversion are remarkably close to the view of scientific revolution that Kuhn expressed in his *Structure of Scientific Revolutions*. Kuhn never refers to this similarity. Was he aware of it? In 1995, he claimed he had made a point of *not* reading *Personal Knowledge* when he was composing *Scientific Revolutions*.⁵⁹ As I indicated above, this sounds more than a little strange, given that in *Scientific Revolutions* itself Kuhn praised Polanyi’s brilliant development of “a very similar theme” (tacit knowledge and its practical mode of acquisition) in *Personal Knowledge*, “particularly [in] chaps. v and vi.”⁶⁰ As also noted above, Kuhn’s “Essential Tension” paper of 1959 is redolent of Polanyi’s ideas, and Kuhn referred to *Personal Knowledge* in his paper at the Oxford Conference of July 1961. Kuhn’s citation in *Scientific Revolutions* of chapter 6 of *Personal Knowledge* is of particular note, given that this is a chapter in which Polanyi discusses, not only tacit knowledge, but the logical gap, conversion and other ideas that bear on the issue of “scientific controversy.”⁶¹ Taken together, these matters provide strong reason to believe that Kuhn came across Polanyi’s coverage of the “logical gap” between frameworks in science while he was preparing his paper for Oxford, which is to say in the first half of 1961 if not earlier, and that he may have read it when he was preparing his conference paper of 1959. Moreover, Kuhn may have heard Polanyi discuss this topic at Palo Alto in 1958, and Polanyi claims he discussed “at considerable length” with Kuhn “his project of the book which was to come out in 1963” in the passage cited by Moleski in footnote 40.

To What Degree May Polanyi and Kuhn Be Seen As Realists?

Polanyi assuredly was a *realist* in the sense of recognizing a physical world or “material universe” as existing independently of, while being an object of, and source of information for, our cognition.⁶² Moreover, Polanyi believed in the *reality of truth* and other ideal ends. These two themes of realism come together in Polanyi’s proposition that the aim of science is to discover *true* knowledge of the *material* world.⁶³

Kuhn was a realist in the first of these senses. He affirmed the existence of an objective physical world, while arguing that the scientist’s conceptualization, description, knowledge and perception of this world, and his research activity in it, are paradigm-dependent and are fundamentally changed in the course of a scientific revolution. Truth, however, plays no part in Kuhn’s analysis of science. Kuhn mentions truth on only two pages

in the body of *Scientific Revolutions*.⁶⁴ He does so in the immediate context of describing the development of science as evolutionary, denying that science progresses toward some end state, as for example “one full, objective, true account of nature.”⁶⁵ In his “Postscript – 1969,” added to the second edition of *Scientific Revolutions*, Kuhn writes that “One often hears that successive theories grow ever closer to, or approximate more and more closely to, the truth.” This, he explains, refers to a theory’s “ontology, to the match . . . between the entities with which the theory populates nature and what is ‘really there’.”⁶⁶ Such a notion of truth is untenable for Kuhn because there is “no theory-independent way” to ascertain what is “‘really there’,” while the very idea that a theory’s ontology might correspond to “its ‘real’ counterpart in nature” strikes Kuhn as void.⁶⁷ Historically, there is no obvious “direction of ontological development” in the succession of paradigms in science; to the contrary, the ontology of “Einstein’s general theory of relativity is closer to Aristotle’s than either of them is to Newton’s.”⁶⁸ Kuhn realizes there will be readers who would describe him as a cognitive relativist, although he denies that he is one. If, however, his theory is relativist, the fact remains, so far as Kuhn is concerned, that it has not omitted “anything needed to account for the nature and development of the sciences.”⁶⁹

Polanyi affirms that truth “exists by itself,” and that it is unitary, not plural nor relative.⁷⁰ Truth he sees as lying “in the achievement of a contact with reality – a contact destined to reveal itself further by an indefinite range of yet unforeseen consequences.”⁷¹ Polanyi writes by way of illustration: “I believe accordingly – in view of the subsequent history of astronomy – that the Copernicans were right in affirming the truth of the new system, and the Aristotelians and theologians wrong in conceding to it merely a formal advantage . . . Copernicanism could well have been a source of truth . . . even if it had been false. But the Copernican system did not anticipate the discoveries of Kepler and Newton accidentally: it led to them *because* it was true. In saying this we are using the term ‘true’ to acknowledge the indeterminate veridical quality of Copernicanism.”⁷²

Polanyi’s thinking on the subject of scientific change displays different tendencies. There are passages in *Personal Knowledge* in which, as I have just indicated, Polanyi suggests that scientific knowledge is progressive as regards the truth. Thus, “Dalton’s atom proved a mere shadowy prefiguration of its successor, the atom of Rutherford and Bohr. Once more it was proved – and this time on a vast scale – that a scientific theory, when it conforms to reality, gets hold of a truth that is far deeper than its author’s understanding of it.”⁷³

One gains a different picture in Polanyi’s account of “Scientific Controversy” (150ff.) in *Personal Knowledge*. Here his ideas suggest that developments in scientific knowledge may be discontinuous. Separated by a logical gap, frameworks, we recall Polanyi as explaining, offer “a new vision of reality;”⁷⁴ terms, concepts, facts, and modes of reasoning are *peculiar* to frameworks, and upholders of each framework occupy “a different world.”⁷⁵ Different vocabularies “divide men into groups which cannot understand each other’s way of seeing things and of acting upon them.”⁷⁶ Their aesthetics, valuations, and scales “of interest and plausibility” are different.⁷⁷ It is not possible for scientists adhering to different frameworks to meaningfully *compare* their views for the accuracy of their predictions, the scope and depth of their explanations, and their empirical-informative content. They cannot demonstrate any proposition to each other. In the final analysis it is, as Polanyi says, “conversion” rather than reasoned analysis that moves scientists to adopt a new framework.⁷⁸ These are ideas of Polanyi that foreshadow and, I have suggested, represent a likely source of, Kuhn’s theory of incommensurability.

Endnotes

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1. Steve Fuller, *Thomas Kuhn: A Philosophical History for Our Times* (Chicago: University of Chicago Press, 2000), 1.
2. Struan Jacobs, "Polanyi's Presagement of the Incommensurability Concept," *Studies in History and Philosophy of Science* 33 (2002), 105-120.
3. Michael Polanyi, "Commentary," *Scientific Change*, ed. A. C. Crombie (London: Heinemann, 1963), 375-380.
4. Michael Polanyi, "Background and Prospect," *Science, Faith and Society* (Chicago: University of Chicago Press, 1964), 12, 13.
5. Michael Polanyi, *Personal Knowledge* (London: Routledge & Kegan Paul, 1958), 124. In his *Logic of Liberty*, 51-52, and 89, however, Polanyi gives a rather different impression as to the degree of difficulty that scientists encounter in trying to discover good problems for their research.
6. Polanyi, *Personal Knowledge*, 125 emphasis added.
7. Thomas Kuhn, "The Essential Tension: Tradition and Innovation in Scientific Research," (1959), in Kuhn, *The Essential Tension* (Chicago: University of Chicago Press, 1977), 225-239. Polanyi, *Personal Knowledge*, 120; *Logic of Liberty*, 39-40.
8. Kuhn, *Essential Tension*, 330; Polanyi, *Logic of Liberty*, 55; *Personal Knowledge*, 135ff.
9. Thomas Kuhn, et al., "A Discussion with Thomas S. Kuhn," *The Road Since Structure*, eds. J. Conant and J. Haugeland (Chicago: University of Chicago Press, 2000), 296.
10. Kuhn et al., "Discussion with Thomas S. Kuhn," *Road Since Structure*, 289.
11. Leonard K. Nash, *The Nature of the Natural Sciences* (Boston: Little Brown, 1963); Robert K. Merton, "The Sociology of Science: An Episodic Memoir," *The Sociology of Science in Europe* (Carbondale: Southern Illinois University Press, 1977), 88.
12. Moleski, "Polanyi vs. Kuhn," 9-10. Kuhn's book, *The Copernican Revolution*, first appeared in 1957, not, as Moleski reports on page 9, in 1959.
13. See note 7 above for bibliographical details.
14. Kuhn, "Discussion," *Scientific Change*, 392.
15. Moleski, "Polanyi vs. Kuhn," 21 quoting David K. Naugle, *Worldview: The History of a Concept* (Grand Rapids: Eerdmans, 2002), 198.
16. Kuhn, "The Function of Dogma in Scientific Research," *Scientific Change*, 392-393 emphasis added.
17. See also *Essential Tension*, xix, where Kuhn, referring to his preparation of "The Essential Tension" essay "early in 1959," makes a similar claim about his having independently discovered the concept of tacit knowledge. One infers from the text of his paper for the Oxford conference of 1961 that Kuhn had read Polanyi's "perceptive and challenging" *Personal Knowledge*, or important parts thereof, before or as he produced the paper. See Kuhn, "Function of Dogma," *Scientific Change*, 392.
18. See Kuhn, *Scientific Revolutions*, 1st ed., viii-xiv. Also relevant, but not entirely consistent with the acknowledgements in the "Preface" of *Scientific Revolutions*, are Kuhn's recollections of his intellectual debts in the "Discussion" of 1995 that is reproduced in *Road Since Structure*, 274ff.
19. Kuhn, *Essential Tension*, 262 and note.
20. Kuhn, *Scientific Revolutions*, 2nd ed., 191.

21. Moleski, "Polanyi vs. Kuhn," 17; Kuhn et al., "Discussion," *Road Since Structure*, 296-297.
22. Kuhn et al., "Discussion," *Road Since Structure*, 297.
23. Kuhn et al., "Discussion," *Road Since Structure*, 297.
24. Kuhn et al., "Discussion," *Road Since Structure*, 296.
25. R. Westman, "Two Cultures or One," *Isis*, 85 (1994), 83.
26. Thomas S. Kuhn, *The Copernican Revolution* (Cambridge, Mass: Harvard University Press, 1959 (first published 1957)), 264 emphasis added.
27. Kuhn, *Copernican Revolution*, 265; also Kuhn, "Essential Tension" (1959), reprinted in Kuhn, *Essential Tension*, 226-227.
28. Polanyi, *Personal Knowledge*, 288.
29. Polanyi, *Personal Knowledge*, 94, 112, 289.
30. Polanyi, *Personal Knowledge*, 80.
31. Polanyi, *Personal Knowledge*, 47, 286ff.
32. Polanyi, *Personal Knowledge*, 150-160.
33. Polanyi, *Personal Knowledge*, 13, 293.
34. Polanyi, *Personal Knowledge*, 105-106, 111-112.
35. Polanyi, *Personal Knowledge*, 18.
36. Polanyi, *Personal Knowledge*, 151.
37. Critical of this part of my interpretation, Gulick has suggested to me that Polanyi looks on the frameworks of Newton and Einstein, and on other such successive frameworks in science, as *related* by subsumption. Having been provided with no reference by him, I am unsure as to which passage(s) in *Personal Knowledge* Gulick has in mind. In reading the pertinent pages 14 and 15 of *Personal Knowledge*, however, my impression is that Polanyi's Einstein *subverts*, rather than subsumes, Newton's theory. It is *discontinuity* between the frameworks that Polanyi is surely underlining on those pages.
38. Polanyi, *Personal Knowledge*, 143.
39. Polanyi, *Personal Knowledge*, 151.
40. Polanyi, *Personal Knowledge*, 60; 150.
41. Polanyi, *Personal Knowledge*, 59, 130, 135, 152-153, 158-161, 165, 167, 170, 201.
42. Polanyi, *Personal Knowledge*, 60.
43. Polanyi, *Personal Knowledge*, 158.
44. Polanyi, *Personal Knowledge*, 152. Gulick has advised me that "a lot more could be said about the commonly shared tacit powers embedded in intellectual passions." Quoting from *Personal Knowledge* (189), he argues that Polanyi believed that, by way of these "powers", mathematicians accomplish a "tacit bridging of the logical gaps internal to every formal proof." This fact, for Gulick, "defend[s] Polanyi against charges that he constructs incommensurable realms." I would point out, however, that Polanyi continues the same passage in *Personal Knowledge* by affirming the occurrence of "radical conceptual inventions opening up altogether new vistas" in mathematics (189). Citing Cantor's proofs in the mathematical theory of aggregates, Polanyi describes how they "traversed a logical gap across which only those willing to enter into their meaning and capable of grasping it could follow him. Reluctance or incapacity to do so caused divisions among mathematicians, similar to those which arose between van't Hoff and Kolbe on the subject of the asymmetric carbon atom, or between Pasteur and Liebig on that of fermentation as a vital function of yeast. Hadamard describes how he and ...Lebesgue, finding themselves on opposite sides of this dispute, were compelled to recognize the *impossibility of understanding each other*" (190 emphasis added).
45. Kuhn, *Scientific Revolutions*, 92, 139. These references to *Scientific Revolutions*, and those that follow, are to its 2nd edition unless otherwise indicated.
46. Kuhn, *Scientific Revolutions*, 102, 109; also 103, 105, 128, 144.

47. Kuhn, *Scientific Revolutions*, 111, 130, 142; also 126, 129.
48. Kuhn, *Scientific Revolutions*, 110, 111, 121.
49. Kuhn, *Scientific Revolutions*, 120, 129 emphasis added; also 111, 117, 118.
50. Kuhn, *Scientific Revolutions*, 121; also 150.
51. Kuhn, *Scientific Revolutions*, 96.
52. Kuhn, *Scientific Revolutions*, 120, 121, 126.
53. Kuhn, *Scientific Revolutions*, 127.
54. Kuhn, *Scientific Revolutions*, 114, also 120.
55. Kuhn, *Scientific Revolutions*, 115, 128.
56. Kuhn, *Scientific Revolutions*, 116, 118, 119, 129.
57. Kuhn, *Scientific Revolutions*, 109, 141, 148.
58. Kuhn, *Scientific Revolutions*, 94.
59. Kuhn et al., "Discussion," *Road Since Structure*, 296-297.
60. Kuhn, *Scientific Revolutions*, 44 n.
61. Polanyi, *Personal Knowledge*, 150-160.
62. Polanyi, *Personal Knowledge*, 47.
63. This is a superficial rendering of Polanyi's views. As Mullins has reminded me, Polanyi's understanding of reality is broad and distinctive. For example, his reality includes the objects of mathematics (*Personal Knowledge*, 186).
64. Kuhn, *Scientific Revolutions*, 170, 171.
65. Kuhn, *Scientific Revolutions*, 171.
66. Kuhn, *Scientific Revolutions*, 206.
67. Kuhn, *Scientific Revolutions*, 206.
68. Kuhn, *Scientific Revolutions*, 207.
69. Kuhn, *Scientific Revolutions*, 207.
70. Polanyi, *Personal Knowledge*, 305.
71. Polanyi, *Personal Knowledge*, 147.
72. Polanyi, *Personal Knowledge*, 147.
73. Polanyi, *Personal Knowledge*, 43 text and n. 1; also 104, 147, 153, 165, 276-277.
74. Polanyi, *Personal Knowledge*, 150.
75. Polanyi, *Personal Knowledge*, 151.
76. Polanyi, *Personal Knowledge*, 112.
77. Polanyi, *Personal Knowledge*, 135.
78. Polanyi, *Personal Knowledge*, 151.

WWW Polanyi Resources

The Polanyi Society has a World Wide Web site at <http://www.missouriwestern.edu/orgs/polanyi/>. In addition to information about Polanyi Society membership and meetings, the site contains the following: (1) the history of Polanyi Society publications, including a listing of issues by date and volume with a table of contents for recent issues of *Tradition and Discovery*; (2) a comprehensive listing of *Tradition and Discovery* authors, reviews and reviewers; (3) digital archives containing many past issues of *Tradition and Discovery*; (4) information on locating early publications not in the archive; (5) information on *Appraisal* and *Polanyiana*, two sister journals with special interest in Polanyi's thought; (6) the "Guide to the Papers of Michael Polanyi", which provides an orientation to archival material housed in the Department of Special Collections of the University of Chicago Library; (7) photographs of Polanyi; (8) links to a number of essays by Polanyi.