POLANYI'S PRESAGEMENT OF THE INCOMMENSURABILITY CONCEPT[1]

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ABSTRACT

Kuhn and Feyerabend have little to say about the thought of Michael Polanyi, and the secondary literature on Polanyi's relation to them is meagre. I argue that Polanyi's view, in *Personal knowledge* and in other writings, of conceptual frameworks 'segregated' by a 'logical gap' as giving rise to controversies in science foreshadowed Kuhn and Feyerabend's theme of incommensurability. The similarity between the thinkers is, I suggest, no coincidence.

1. Introduction

Were Kuhn and Feyerabend influenced in their analysis of science by Michael Polanyi? Their respective principal works each cite Polanyi once (Kuhn, 1962, p. 44 n. 1; Feyerabend, 1975, p. 166). Among the few thinkers to comment on Polanyi's effect on Kuhn is MacIntyre (1980, p. 67), who states that Kuhn was 'indebted' to Polanyi for his account of science but that 'Kuhn nowhere acknowledges any such debt'.[2] Hoyningen-Huene (1993, p. 119 n. 269 and text) took umbrage at MacIntyre's thinly veiled allegation that Kuhn had plagiarised from Polanyi. Nevertheless it is indicative of the common tendency to ignore, rather than to explore, whether Polanyi contributed to Kuhn's thought that Hoyningen-Huene mentions Polanyi on only two pages of his monograph on Kuhn and cites no text of Polanyi in its extensive bibliography (25-odd pages).[3]

In this paper I argue that Polanyi presaged Kuhn and Feyerabend's motif of incommensurability. The paper is motivated by a concern to shed light on this

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[2] As can be seen from my previous sentence in the body of the article, MacIntyre's remark is not quite correct; it is, however, close to the mark. Kuhn refers to Polanyi once in *The structure of scientific revolutions*, praising his account of tacit knowledge, and once in his essay collection *The essential tension* (Kuhn, 1977, p. 262). Fuller (1992, p. 260) expresses a similar view to that of MacIntyre concerning Polanyi's impact on Kuhn, writing 'it is not hard to see that Kuhn owed more to Polanyi than the couple of footnotes to *Personal knowledge* would suggest'.

[3] Again, Westman (1994) and Krige (1980) never mention Polanyi.

neglected[4] aspect of Polanyi's writing, examining an important moment in the history of one of the major metascientific themes in recent decades.

Kuhn (1983, pp. 669, 684 n. 2) has noted that he and Feyerabend independently introduced the term 'incommensurability' into the 'philosophy of science …in 1962'. Kuhn is vague on how he acquired the concept of incommensurability. He recalls that reading Aristotle in 1947 proved 'decisive' for him in disclosing

> a global sort of change in the way men viewed nature and applied language to it, one that could not properly be described as constituted by additions to knowledge or by the mere piecemeal correction of mistakes. That sort of change was shortly to be described by Herbert Butterfield as 'putting on a different kind of thinking-cap,' and puzzlement about it quickly led me to books on Gestalt psychology and related fields. While discovering history, I had discovered my first scientific revolution … (Kuhn, 1977, p. xiii)

Kuhn's footnote, in this case, records that his 'own understanding of the transformation of modern science' was, like that of Butterfield, 'greatly influenced by the writings of Alexandre Koyré, especially his *Etudes galiléennes* (Paris, 1939)'. Was Kuhn effectively in possession of the concept of incommensurability when he wrote *The Copernican revolution* (1957)? Heilbron (1998, p. 508) suggests an affirmative answer, but Westman (1994, pp. 83–85) has carefully argued that Kuhn's account of scientific revolution in *The structure of scientific revolutions* is more radical than is his account in the Copernican study. In *The Copernican revolution*, writes Westman (1994, p. 83), 'scientific facts' for Kuhn 'appear to exist independently of concepts. Theories can organize facts, but they do not inevitably determine the character of observation. Thus in a revolution there is no change in the epistemological status of earlier observed phenomena: they are simply reorganized using different concepts'. Westman's interpretation is borne out by Kuhn's description of disclosures of 'phenomena' and of 'order in fields of experience' as 'permanent achievements' (Kuhn, 1957, p. 264; emphasis added). So long as science remains a 'continuous tradition', Kuhn considers that scientists will 'be able to explain the phenomena first elucidated by Newtonian concepts, just as Newton [could explain the] phenomena previously elucidated by

[4] Besides the works cited in the last note, Polanyi is omitted from the historiographical works on scientific revolution of Bernard Cohen (1985) and Floris Cohen (1994), and from the analyses of incommensurability by Brown (1983) and Sankey and Sankey.
To forestall misunderstanding, I should point out that I am not devoting my paper to the history of the idea of incommensurability. I am interested in Polanyi as a, and I believe the, main source of the idea in Kuhn and Feyerabend. There were thinkers besides Polanyi who prefigured the theme of incommensurability, although I am aware of no evidence of their having affected Polanyi, Kuhn or Feyerabend on this topic. Giedymin (1982, p. 192) points out that a concept of incommensurability found favour with LeRoy, Duhem and Ajdukiewicz, although not with Poincaré. (See also Giedymin, 1978, pp. xxxi ff.) I am indebted to one of the referees for drawing my attention to incommensurability in the writings of the conventionalists.

Aristotle and Ptolemy'. In contrast to explicable phenomena which constitute a cumulative class through the history of science, concepts and explanations 'are repeatedly destroyed and replaced' (Kuhn, 1957, p. 265; see also Kuhn, 1959, paper reprinted in Kuhn, 1977, pp. 226–227). This is not incommensurability as Kuhn conceives of it in *The structure of scientific revolutions*.[5]

Polanyi's *Personal knowledge*, published in 1958, may well have contributed to Kuhn's more radical understanding of scientific revolutions. Kuhn had certainly read Polanyi's book by July 1961 (and also Polanyi's 1951 essay collection *The logic of liberty*), for he declared (Kuhn, 1962, p. 392) at a symposium held at the University of Oxford in that year, that

> I have …recently recognized …[that] Mr. Polanyi himself has provided the most extensive and developed discussion I know of the aspect of science which led me to my apparently strange usage [of the word *paradigm*].
>
> In his perceptive and challenging book, *Personal knowledge*, Mr. Polanyi repeatedly emphasizes the indispensable role played in research by what he calls the 'tacit component' of scientific knowledge …I agree that neither the methodological nor the substantive requisites for sound research can be fully articulated …

There is reason, indeed, to believe that Kuhn was reading *Personal knowledge* in 1959.[6]

Paul Feyerabend deals directly with the origins of his idea of incommensurability on several occasions. In *Science in a free society* Feyerabend (1978, p. 114) indicates that discussions with G. E. M. Anscombe led him to the idea of 'conservation principles', an idea, Feyerabend suggests, that came to play an important part in the development of his understanding of incommensurability.[7] In the same work Feyerabend (1978, pp. 66–68, 114–117) notes that Wittgenstein's work contributed to Feyerabend's working out of the idea of incommensurability. Of greater interest to us, however, is Feyerabend's late recollection that 'somewhere along the way I read an interesting

[5] Documents presented by Hoyningen-Huene (1995, p. 357) make it clear that Kuhn was using the term incommensurability in 1961.

[6] The evidence for this surmisal is in Kuhn's script 'The essential tension', for a conference in 1959. Variants of a number of themes in Polanyi's *Personal knowledge* are to be found in this composition of Kuhn, including: knowledge of the kind that Polanyi described as tacit, anomalies as ubiquitous in science, cognitive tradition (a more robust concept of tradition, at any rate, than is to be found in Kuhn's *Copernican revolution*), scientific training as illiberal and even authoritarian, and the idea of the scientific community (the expression, 'scientific community', made famous by Kuhn, seems to have been coined by none other than Polanyi—see Jacobs & Mooney, 1997).

[7] Interestingly, however, neither 'Anscombe' nor 'conservation principles' appears in the index of *Against method*. Polanyi is mentioned only once in *Against method* but none of his works is cited, and there is no mention of Polanyi in Feyerabend's autobiography, *Killing time* (Feyerabend, 1995).

paper by Michael Polanyi on the world view of the Azande' (Feyerabend, 1991, pp. 492, 501). This impressed Feyerabend as 'a concrete application of Wittgenstein's advice to look and see and not to wander off on an abstract tangent'. Preston (1997, pp. 30–31) has indicated that the essay of Polanyi's to which Feyerabend alludes—'The stability of beliefs'—exerted a great influence on Feyerabend's thinking during the early 1960s in the construction of 'What Feyerabend referred to as his own preferred "model for the acquisition of knowledge" ' and that it raised an important issue for Feyerabend in the form of 'Whether we can give *good reasons*' for our preferring science to systems such as Azande witchcraft.

In the present paper two of Polanyi's writings that illuminate his ideas about frameworks and which importantly presage Kuhn and Feyerabend's ideas of incommensurability will be discussed. These writings are Polanyi's 'The stability of beliefs' (1952), and a section on 'Scientific controversy' in chapter 6 ('Intellectual passions') of Polanyi's masterwork, *Personal knowledge*. (Most of the 1952 essay is reproduced in *Personal knowledge*.)

2. Language embodies worldview

Polanyi's aim in 'The stability of beliefs' (Polanyi, 1952, p. 218) is to describe the principles by which conceptual frameworks keep their followers' minds in thrall. While 'The stability of beliefs' contains no explicit discussion of what, if any, relations exist between conceptual frameworks, it does present a proposition that has significant implications for the question of framework relations: 'theories of the universe' permeate languages. The resistance of belief systems to criticism was not a new theme in Polanyi's *oeuvre* in 1952. He had discussed the persistence of tradition and the power of orthodoxy in science over a number of years. The novelty in Polanyi's thinking in 1952 was that he was treating the theme of resistance *comparatively*, extending his argument beyond science to other belief systems. The 1952 essay also shows that Polanyi had become acutely aware of the extent to which worldviews penetrate into language, and that he had sensed that this may have important ramifications for relations between frameworks of belief.

As the basis of his argument, Polanyi gives a precis of his epistemology as he had explicated it in *Science, faith and society* (Polanyi, 1946) and 'Scientific beliefs' (1951). Polanyi (1952, pp. 218–219) considers that 'discovery, verification and falsification' of propositions in science do not obey 'any definite rule' but proceed with the aid of 'certain maxims' which defy both precise formulation and rigorous evaluation. The maxims are 'premisses or beliefs … embodied in … the tradition of science'. Sustained by this tradition, science is governed by the coherent opinion of its practitioners, who employ the 'idiom of science in which its interpretative framework is expressed' (Polanyi, 1952, p. 219). The belief of scientists that science is true is a personal conviction which they cannot factually justify.

Among the many different understandings of the world besides science, Polanyi in 'The stability of beliefs' cites Azande witchcraft, Marxism and psychoanalysis. These conceptual frameworks Polanyi (1952, p. 219–220) variously describes as 'reflected in', 'expressed in the use of', 'embedded in', 'embodied' in and 'upheld' by their corresponding languages, which form 'idioms of belief'. Polanyi traces this view back to Lévy-Bruhl,[8] and finds abundant confirmation of it in Evans-Pritchard's investigation of Azande witchcraft. Azande belief is 'embedded in an idiom which interprets all relevant facts in terms of witchcraft and oracular powers' (Polanyi, 1952, p. 220). Evans-Pritchard had been struck by how effectively the Azande reason ' "in the idiom of their beliefs" ' while noting that ' "they cannot reason outside, or against, their beliefs because they have *no other idiom in which to express their thoughts*" ' (quoted in Polanyi, 1952, p. 221; emphasis added by the present author).

Polanyi went on to develop a general view of the linguistic embodiment of belief systems. He contended that the worldview of each language lies implicit in its 'vocabulary and structure' (Polanyi, 1952, p. 221). A vocabulary is likened by Polanyi to the theory of chemical compounds, being 'a definite theory of all subjects that can be talked about' and of the ascription to these subjects of 'recurrent features' which the words mark. Each such worldtheory includes certain conceptions while excluding others. A language constrains what questions can be formulated, and answers to these questions serve to confirm the theory implicit in the language.

The thesis of worldviews as embodied in languages—predating the publication of Whorf's essay-collection (1956)—is repeated by Polanyi in *Personal knowledge* (Polanyi, 1958, pp. 80, 94, 112, 287, 289). With reference to the theories of Evans-Pritchard and Lévy-Bruhl, Polanyi explains in *Personal knowledge* that each 'descriptive term' of ordinary language 'implies a generalization affirming the stable or otherwise recurrent nature of some feature to which it refers', and together these 'recurrent features constitute … a theory of the universe which is amplified by the grammatical rules according to which the terms can be combined to form meaningful sentences' (Polanyi, 1958, p. 94).

Polanyi indicates that it is impossible for frameworks of belief to be evaluated from within. Using a given language to challenge its embodied theory issues in self-contradictions. The worldview can only be questioned after its language has been exchanged for another (Polanyi, 1952, pp. 221–222). Polanyi (1952, p. 218) quotes from Koestler and Horney who had regarded the 'interpretive powers' of

[8] A remark of Lévy-Bruhl (1928, p. 233), conveying some of the flavour of his thinking, is: "Do not let us propound to primitives questions which escape their mentality, posed in terms involving a system of metaphysics of which they have not the remotest idea. Let us avoid asking them how they solve problems that they have never even considered. The fate of the individual in the Beyond creates no uneasiness in a primitive's mind, and he has little to say about it. Let us not try to discover in his representations the distinction we make between soul and body. On the contrary, let us endeavour to grasp them without distorting them … and not force them into the framework which befits our own concepts." Further revealing passages are to be found on pp. 54, 170 and 278 of Lévy-Bruhl's book.

their respective Marxian and Freudian frameworks 'as evidence of …[their] truth'. As their faith collapsed, the two thinkers came to view the 'powers' of the doctrines as 'excessive and specious'.

Worldviews are immanent or indwelling in languages, Polanyi argued in 1952, being *shapers* as well as instruments of thought. The implication is that no language can serve as a neutral medium for comparing belief systems embedded in other languages.

3. Intellectual passions

In sections of *Personal knowledge* to which we now turn, Polanyi's focus differs from that in 'The stability of beliefs', and he carries out his analysis at a lower level of generality. Having previously juxtaposed science with non-scientific idioms and worldtheories, Polanyi now turns his attention to systems of belief *within* science.

Polanyi's account of 'intellectual passions' constitutes an important part of the background to his theory of scientific controversy. The expression 'intellectual passion' has an unusual ring to it on account of its connecting faculties that we commonly take to be contrasting opposites. The expression is reminiscent of Pascal's 'reasons of the heart'. 'Intellectual passion' is applied by Polanyi to feelings of attraction or of antipathy to beliefs. Polanyi is particularly interested in the composition of the emotions of inquirers and in the part that their emotions play in science. Intellectual passion is understood by Polanyi as essential to making scientific discoveries but as fallible and capable of misdirection.

Intellectual passions have cognitive or *affirmative content*, with a corresponding '*selective function*' in regard to knowledge. An inquirer is attracted to a discovery, her passion aroused by and affirming the interest, value and beauty of the discovery to science (Polanyi, 1958, pp. 134ff.). For Polanyi (1958, p. 145), a theory's beauty is 'a token of its contact with reality'. Paraphrasing Polanyi, Allen (2000, p. 38) writes of 'the felt conviction' of the value of statements 'which selects them as worthy of pursuit'. The selective function of intellectual passion contributes to the constitution and definition of science at the time. Galileo's commitment to heliocentricism over Ptolemaic astronomy Polanyi attributes not to reasoned argument but to Galileo's 'passionate appreciation of …[its] greater scientific value', while his adversaries were emotionally committed to retaining humanity's privileged position in the universe (Polanyi, 1958, p. 152).

Intellectual passions combine a *conative component* with a *heuristic function*. In its heuristic function intellectual passion guides a scientist by evoking 'intimations of specific discoveries', and through its conative aspect intellectual passion sustains the often protracted pursuit of those discoveries (Polanyi, 1958, p. 143). As an example, Polanyi (1958, pp. 7, 143) quotes from *Harmonices Mundi* (Book 5, Chapter 10), where Kepler recalls how he ' "prophesied two-and-twenty years ago …that for which I have

devoted the best part of my life to astronomical contemplation" ', namely how it is that the sun as centre of the cosmos 'apprehends the celestial music performed by the planets'. (Intellectual passion, as noted, is not always reliable.)

There is a *persuasive function* of intellectual passions which Polanyi sees as coming to the fore in scientific controversies. Passionately committed to their established conceptual framework, most scientists are antagonistic toward a new system of belief and its implications. Driven by intellectual passion in its persuasive capacity, the putative discoverer tries to attract scientists away from orthodoxy to her new framework and its 'class of alleged facts' (Polanyi, 1958, p. 150). The claimed discovery may never become part of socially accredited knowledge: it 'must conquer or die' (Polanyi, 1958, p. 150).

There are two reasons why scientific controversy forms a major topic for Polanyi. He sees controversy as shaping the content of science, its values and methods, and at the meta level Polanyi's analysis of scientific controversy informs his extensive argument against 'objectivism' (Polanyi, 1958, pp. 158, 170). A bloodless caricature of science, 'objectivism', as regarded by Polanyi (1958, pp. 16–17, 214), affirms that the content of scientific statements is 'entirely determined by observation' and logic, exclusive of personal factors. Were objectivism true, Polanyi (1958, p. 159) argues, scientists would settle their differences by way of facts, reasoned argument, external criteria and 'systematic and dispassionate empirical investigations'. Polanyi, as we have noted, sees scientific controversies arousing intense emotions and defying rational negotiated settlement. Objectivism may be at a loss to account for scientific controversies; so then how does Polanyi explain them?

4. Gaps between frameworks

In a Polanyian scientific controversy, supporters of a heterodox conceptual framework endeavour to wrest 'scientific value' away from orthodoxy and its upholders. Frameworks in a scientific controversy are described by Polanyi as 'alternatives' or 'rivals', but, as we shall see, his use of such terms is figurative. ('Incommensurability' is not among the terms he uses in this context in *Personal knowledge*.[9]) Conceptual frameworks cited by Polanyi (1958, pp. 151–158) include Freud's psychology, Eddington's *a priori* system of physics, Rhine's 'Reach of the Mind' and Lysenko's biology, the astronomical theories of Ptolemy and Copernicus, Pasteur's account of alcoholic fermentation as a living function of yeast and the view

[9] Polanyi (1958, p. 174) does, however, use the term in other contexts, writing for example of the 'incommensurability' of elements 'in a technical performance'. And in *The logic of liberty* (1951), discussing Rousseauan romanticism, Polanyi writes 'Creative genius claimed to be the renewer of all values and therefore to be incommensurable. This claim was to be extended to whole nations; according to it, each nation had its unique set of values which could not be validly criticized in the light of universal reason' (Polanyi, 1951, p. 100).

of Wöhler, Liebig and Berzelius that yeast in fermentation is a chemical precipitate, extra-sensory perception, epiphenomenalism and volitional neurology.

Given what Polanyi writes about scientists' passionate commitment to established conceptual systems, and the malleability he attributes to those frameworks, the wonder is that new conceptual frameworks are even conceived of, let alone that some of them eventually oust traditional ones from science. A framework is able to explain 'most of the evidence' but never all of it, and adherents, impressed by the framework's 'coherence', set aside 'for the time …being facts, or alleged facts, which it cannot interpret' (Polanyi, 1958, p. 151). The supporters expect that these pieces of evidence will eventually be explained, or else be explained away as spurious beliefs (Polanyi, 1958, pp. 13, 47, 51, 138, 158, 167). Polanyi stresses the resistance of frameworks, resistance, and the lack of interest of their protagonists in subjecting frameworks to criticism. He writes that 'discrepancies' are often classed as '*anomalies*', a prize example being 'the perturbations of the planetary motions that were observed during 60 years preceding the discovery of Neptune' (Polanyi, 1958, p. 20; emphasis added). These recordings were 'set aside' for explanation in the future and were not taken by the majority of astronomers as a sign that the Newtonian framework was defective (Polanyi, 1958, p. 20; Polanyi, 1950, p. 29).

The framework undergoes what Polanyi (1958, pp. 18, 105–106) describes as 'programmatic' development, as its conceptions are used to assimilate, and are adapted to, unprecedented instances—the 'tacit art' of simultaneously applying and reshaping conceptions. A case in point is Urey's addition of deuterium to the isotopes of hydrogen, while Soddy vainly objected that this violated the meaning of 'isotope', which required isotopes of an element to be chemically inseparable from each other. A Polanyian framework also develops through the unfolding of its theoretical implications, with new facets of reality discovered (Polanyi, 1958, pp. 5, 104, 147, 160). The ancient atomists, seventeenth-century corpuscularians and John Dalton, for example, 'beheld and described the dim outline of a reality which modern atomic physics has since disclosed' in detail (Polanyi, 1958, p. 104).

Although the theme of commitment to orthodoxy is in the foreground of Polanyi's discussion, occasionally he mentions that anomalies may eventually cause frameworks to be questioned. In what is perhaps his clearest reference to this type of development, Polanyi (1958, p. 18) writes that 'every system of thought has of course some loose ends tucked away… Yet it is a fact that time and again men have become exasperated with the loose ends of current thought and have changed over to another system, heedless of similar deficiencies within that new system'. Otherwise Polanyi has little to say concerning the sorts of circumstances that arouse scientists' affirmative and conative intellectual passions, urging scientists to discover frameworks and prompting others to switch their allegiance to new frameworks.[10]

[10] See also Polanyi's discussion, transposed from 'The stability of beliefs', which has obvious relevance to scientific controversies (Polanyi, 1958, pp. 286ff.).

In one very revealing passage Polanyi (1958, p. 151) writes that

> two conflicting systems of thought are separated [or 'segregated'] by a logical gap… Formal operations relying on *one* framework of interpretation cannot demonstrate a proposition to persons who rely on *another* framework. Its advocates may not even succeed in getting a hearing from these, since they must first teach them a new language, and no one can learn a new language unless he first trusts that it means something.

The idea of the *logical gap* between frameworks controls Polanyi's understanding of scientific controversy. Polanyi (1958, p. 151) believes that conceptual frameworks in a controversy have this logical gap 'in the same sense as a problem is separated from the discovery which solves the problem'. The logical gap between a problem and its undiscovered solution consists for Polanyi (1958, p. 123) in the fact that no rule or logical procedure leads from existing knowledge to the solution which is unpredictable. (Maxims may be of limited assistance to a discoverer trying to cross the gap but they are inherently vague (Polanyi, 1958, p. 125; Prosch, 1986, pp. 143, 223).) As Polanyi (1958, pp. 125, 143) explains it, the logical gap between a problem and its solution can only be crossed *heuristically*, by the inquirer trying to guess right. The first crossing occurs with an intellectual leap, an act of originality producing illumination. The solution is at once a Gestalt mental reorganisation and an emotional upheaval, the discovery being discontinuous with previous knowledge.

Polanyi uses the analogy of the gap between a problem and its solution to throw into relief his contention that conceptual frameworks in a scientific controversy are logically disconnected or 'segregated'. Typically, no relation of entailment, contradiction or disjunction exists between the frameworks. The width of the logical gap is shown, says Polanyi (1958, p. 151; emphasis added), by the fact that, compared with supporters of an established scientific framework, supporters of a new system 'think differently, speak a different language, *live in a different world*'.[11]

Conceptual frameworks are needed in order to make 'sense of experience', each framework incorporating a unique 'vision of reality' (Polanyi, 1958, pp. 60, 150). Adherents of two frameworks in a controversy belong to the same 'material universe', but perceptually and cognitively their worlds are different (Polanyi, 1958, pp. 47, 151). With radically different ontologies, conceptual frameworks separated by a logical gap have no facts in common (Polanyi, 1958, pp. 158, 167).[12]

[11] Polanyi's foreshadowing of the idea of incommensurability is clear here. As Popper (1976, p. 40) would later express it, 'two logically incompatible theories will be, in general, "commensurable". *Incommensurability* is intended to be much more radical than *incompatibility*: while incompatibility is a logical relation and thus appeals to one logical framework, incommensurability suggests the non-existence of a common logical framework.'

[12] Constraints of space prevent us from exploring certain issues with which Polanyi deals that are related to ones we have been considering. One such issue is that controversies change scientists' principles and values. An example is the triumph of Copernicanism, which, on

The ultimate source of difference between Polanyian frameworks lies in their premisses which are implicit in the conduct of researchers and represent objects of fiduciary commitment. An explicit statement of a scientist's *premisses*, writes Polanyi (1958, pp. 59, 165), can only 'reveal the premisses of past scientific achievements. The actual premisses of science, at the moment of writing, are present only in the as yet unformed discoveries maturing in the minds of scientific investigators intent on their work'. (Polanyi's idea is not unlike Collingwood's idea of 'absolute presuppositions'; see Allen, 1990, p. 55.) Resources essential to scientific research are embedded in the premisses of a conceptual framework. Among the resources are substantive ideas, principles of procedure, appreciations of cognitive value (derived from past controversies), indications as to 'questions that it should be reasonable and interesting to explore' and 'the kind of conceptions and empirical relations' that need to be upheld as plausible (Polanyi, 1958, pp. 135, 158–161, 170). Formal and substantive elements of knowledge, express and tacit, are inextricably bound together.

> The rules of scientific procedure which we adopt, and the scientific beliefs and valuations which we hold, are *mutually determined*. For we proceed according to what we expect to be the case and we shape our anticipations in accordance with the success which our methods of procedure have met with. Beliefs and valuations have accordingly functioned as joint premisses in the pursuit of scientific inquiries. (Polanyi, 1958, p. 161; emphasis added)

'Formal operations relying on *one* framework of interpretation cannot demonstrate a proposition to persons who rely on *another* framework' (Polanyi, 1958, p. 151). Arguments from premisses in support of a proposition appear 'wholly specious' from the adversary's point of view (Polanyi, 1958, p. 158). In 1874 van't Hoff explained optical isomerism in terms of asymmetric molecules, their atoms tetrahedrically arranged around a carbon atom. Kolbe, whose conceptual framework involved a high valuation of experimentalism, dismissed van't Hoff's work as 'a tissue of fancies'. Kolbe found it impossible to argue rationally with 'such wild ideas' (Polanyi, 1958, p. 158).

Premisses for Polanyi also determine what counts as credible evidence. What impress scientists as predictive successes and confirmations inside their own framework have no evidential worth in the eyes of scientists who are hostile to that framework. Polanyi (1958, pp. 156–157) finds an illustration of this in the controversy over alcoholic fermentation that began in 1839 and dragged on for the best part of forty years. From 1835 several scientists, on the basis of microscopic observations, were suggesting that fermentation is a product of *live* yeast cells. According to the dominant conceptual framework, yeast as the initial cause of

Polanyi's reckoning (Polanyi, 1958, pp. 152–153, 158, 201), established the principle of moral and religious indifference in science and promoted the ideal of empiricism.

alcoholic fermentation is a chemical agent. Wöhler, Liebig and Berzelius disputed whether the experimentation conducted in support of the live yeast theory was reliable. Supporting the conceptual framework of reductionist explanation to physics and chemistry, Wöhler and his allies fought the other framework as a piece of discredited vitalism.

Because premisses differ so profoundly between conceptual frameworks and form descriptions of different worlds, even if scientists were prepared to learn the other framework's language, its concepts and terms would still not suffice for a rational assessment of the comparative merits of the orthodox and unorthodox systems from a neutral position. This is a matter of logic, not of psychological attitude (for example, resistance, lack of empathy or feeling of antipathy). The lack of a neutral vantage point from which scientists can independently evaluate evidence and arguments makes it understandable to Polanyi that scientific disagreements may be deep, acrimonious and long lasting. Since arguments and evidence are internal to conceptual frameworks they do little to restrain intellectual passions. Choices between frameworks in science are based on passion, with no framework-independent resources to mediate (Polanyi, 1958, p. 152).

Adversaries in scientific controversies justify their '*comprehensive rejection*' of the other framework by depicting it as 'altogether unreasonable'. They resort to *ad hominems*, denigrating the opponent as 'a fool, a crank or a fraud' (Polanyi, 1958, p. 151). Controversies in science remind Polanyi (1958, pp. 151–152) of ideological clashes between Marxists, Nazis and their various enemies. 'And once we are out to establish such charges we shall readily go on to expose our opponent as a "metaphysician", a "Jesuit", a "Jew", or a "Bolshevik", as the case may be'.

There is an unintended irony in Polanyi's analysis: as noted earlier, according to his account of the logical gap, conceptual frameworks are *not* logically in conflict. Frameworks are not alternatives describing the same world in incompatible terms; they are mutually indifferent.[13] Conceptual controversies are fomented by passionate partisans who labour under an illusion, being blind to this indifference.

[13] There is some sliding by Polanyi on this matter. Facts, Polanyi explains, depend on frameworks and are not common between two frameworks that are logically disconnected from each other. Two frameworks sharing facts would, indeed, be logically congruent, not logically 'segregated'. 'Facts which are not described by . . . [a] theory' are regarded by it 'as irrelevant to itself. Such a theory functions as a comprehensive idiom which consolidates that experience to which it is apposite and leaves unheeded whatever is not comprehended by it' (Polanyi, 1958, pp. 47, 150, 287). Polanyi suggests that facts relevant to a framework are at least delineated, and probably in large part formed, by the framework, rather than existing anterior to and independent of it. He writes, 'Our acceptance of facts which makes sense of the clues offered by experience to our eyes and ears' is a process which 'premisses' underlie; premisses that differ radically between frameworks (Polanyi, 1958, p. 162). In contrast to such thinking, however, Polanyi believes that the Ptolemaic and Copernican frameworks accounted for many of the same facts (Polanyi, 1958, pp. 152, 157 n. 3). But this would appear to be a rule-proving exception for Polanyi. Typically, he considers that controversies include what is to count as factual evidence, and they serve to show 'the power of scientific theory over scientific facts'. Polanyi (1958, p. 167) writes that

Notwithstanding the widespread hostility they provoke, new conceptual frameworks may attract some support. For this to occur, however, 'proponents of a new system' must first win others' 'intellectual sympathy for a doctrine they have not yet grasped' (Polanyi, 1958, p. 151). Understanding an alien framework depends on scientists developing an empathic respect for it, for only then can its alien language be learned on the trusting assumption that it is meaningful. (Kolbe made no such concession to van't Hoff and his allies, referring to them as ' "weeds of a trivial ...and empty Philosophy of Nature" '; quoted by Polanyi, 1958, p. 155.) Protagonists of a conceptual framework use rhetorical devices to persuade doubters of its merits. When previously incredulous or hostile scientists become convinced of a framework's truth, they undergo a 'conversion' that leads them into the ranks of the 'disciples' who 'form... a school' (Polanyi, 1958, p. 151). In time a new framework may displace the orthodoxy with which it has been understood to conflict, gaining accreditation from the community of science.

A concept of scientific revolutions is intimated in *Personal knowledge*. As already noted, Polanyi (1958, pp. 150, 152) understands scientific frameworks holistically, as 'virtually complete systems', and he often gives the impression that there is no question of antagonists in a scientific controversy selecting items from a framework and combining them with their own framework. Adversaries reject the other system *in toto*. This, combined with Polanyi's thesis of the logical gap, suggests a concept of scientific revolutions, foreshadowing that of Kuhn.[14] Such a concept is apparent when Polanyi (1958, p. 196) mentions that 'scientific discovery, which leads from one ... framework to its successor, bursts the bounds of disciplined thought'. Indeed, Polanyi (1958, p. 276) explicitly refers to 'revolutionary discoveries', citing 'the heliocentric system' and the discoveries 'of genes, of quanta, of radioactivity or of relativity'. There is, however, a decisive difference of orientation and interest between Polanyi and Kuhn. Kuhn developed his historiography of science with revolution as its *leitmotif*,

adversaries in framework controversies 'do not accept the same "facts" as facts, and still less the same "evidence" as evidence. The terms are ambiguous precisely to the extent to which the two opposing opinions differ. For within two different conceptual frameworks the same range of experience takes the shape of different facts and different evidence'.

[14] Polanyi did not consistently think in terms of radical mutations or supersessions in the way that his thesis of the logical gap would appear to have required of him. In one place in *Personal knowledge*, for example, Polanyi (1958, p. 196; emphasis added) talks of discovery 'occasionally ... demolishing a hitherto accepted structure [conceptual framework], or *parts of it*, in order to establish an even *more rigorous* and *comprehensive one* in its place'. This claim doubly contradicts the thesis of the logical gap, firstly in suggesting the possibility of piecemeal cognitive alteration as distinct from acceptance/rejection of entire frameworks, and secondly in indicating that conceptual frameworks may be comparable. Another proposition made by Polanyi (1958, p. 157, n. 4 and text) that is difficult to reconcile with his thesis of the logical gap, and which would serve to make it a less drastic thesis than so much of Polanyi's discussion otherwise suggests, affirms that 'an apposite new conception can reconcile two alternative systems of interpretation which hitherto violently opposed each other'. What Polanyi forgets in this instance is his view that frameworks of interpretation that are separated by a logical gap are not logical 'alternatives'.

whereas Polanyi developed no explicit historiography (it is telling that the terms 'revolution' and 'scientific revolution' are not in the index of *Personal knowledge*). Polanyi's concern in the section of *Personal knowledge* that we have investigated was not to weave ideas of orthodoxy and heterodoxy, stasis and flux, into a theory of historical pattern. His principal concern, we recall, was to expose the logical empiricist or 'objectivist' account of science as contrary to the facts (Polanyi, 1958, pp. 159, 265). Explaining the relative impotence of facts and reasoned argument in, and in deciding the outcome of, scientific controversies, Polanyi underlined the decisive part played by scientists' intellectual passions.

5. Postscript

We know that Kuhn was acquainted with Polanyi's *Personal knowledge* from quite early in the piece, referring favourably to one of its themes (tacit knowledge) in *The structure of scientific revolutions*. It is highly probable that Feyerabend commenced reading Polanyi's book at some time between 1958 (the year of its publication) and 1962, the year in which he and Kuhn presented the term 'incommensurability' in print. That both men knew Polanyi's book (and that Feyerabend read Polanyi's 'The stability of beliefs', in the 1950s one surmises) suggests that Polanyi's idea of the logical gap between frameworks of belief may well have conditioned Kuhn and Feyerabend as they developed their understandings of incommensurability. The resemblances between their notions of incommensurability and Polanyi's idea of the logical gap separating frameworks of belief are striking.

Other commentators, however, have seen the situation differently than I do. Poirier, for example, contrasts Polanyi's realism with Kuhn's relativism. In Polanyi's account, writes Poirier and Polanyi (Poirier 1989, pp. 271–272; cf. Polanyi, 1958, pp. 5–6, 64)

> A theory is the product of insight … into the real. To the extent that this insight is truly about what is real, it is a wager that the insight … will uncover more of that order than is presently known. And, if more of the order is uncovered, then it is held that the original contact with reality was true, … since it eventually brought more of the the true order, existing independently of man, into the ken of men.
>
> We cannot avoid drawing attention to the fact that, for Polanyi, man the scientist does not *experience himself* as being in charge of the constituents of his insight. He is not inventor of his vision, as … is the case for Thomas Kuhn. Rather, he comes upon it, so that it might be said that he is responding to the beckoning of the real…
>
> Given all of this, how can anyone claim that Polanyi is ontologically a relativist?

What Poirier omits here is the very notion we have closely studied above, that Polanyian frameworks of belief are separated by *a logical gap*. Poirier's failure to discuss the logical gap gives a false impression of the difference between Kuhn and Polanyi.

There is, however, a tension in *Personal knowledge* itself which may go some way toward explaining why I interpret Polanyi as having affinities with Kuhn (and Feyerabend) and why Poirier interprets them as fundamentally different thinkers. On the one hand Polanyi (1958, pp. 47, 315–316) explicitly affirms realism and disclaims cognitive relativism, notwithstanding that he denies an external criterion of truth (Polanyi, 1958, p. 265). This is the strand of Polanyi's thinking on which Poirier focuses. A cognitive relativist would allow that truth is internal to, and constituted by, frameworks, so that frameworks on either side of a logical gap could both be true in their own terms. Polanyi explicitly foreswears such a view. He conceives of truth as objective, a condition of correspondence between frameworks and reality. In the controversy involving Hegel and astronomers over Bode's Law, for example, Polanyi does not allow that Hegel's *Naturphilosophie* and the astronomers' frameworks of belief were equally valid in their own terms. The jury may remain out on whether Bode's Law is a 'mere coincidence' without 'any rational foundation', but, says Polanyi (1958, pp. 154–155), 'the astronomers were right and Hegel was wrong', for the reason that 'the astronomers' guess lay within a conceivable scientific system, and … was a competent guess …; while Hegel's inference was altogether unscientific, *incompetent*. Again, Aristotelians and Copernicans 'agreed on what they meant by "true"; namely, that truth lies in the achievement of a contact with reality … 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' (Polanyi, 1958, p. 147).[15]

Polanyi's thinking on the logical gap between conceptual frameworks runs counter, however, to his anti-relativist strand. Frameworks on either side of a logical gap are not contradictories; they do not make incompatible claims about the same subject matter. Their respective supporters 'live in different worlds'. One framework in a Polanyian scientific controversy does not logically exclude the other. The doctrine of the logical gap implies that both frameworks can be true in their own terms, each generating its own evidence, with no framework-independent position for discriminating between them. The truth of Copernicus, say, does not—tracing out the implications of Polanyi's idea of the logical gap—*logically* entail the falsity of Ptolemy. Copernicus' system replaced that of Ptolemy and it intimated many important discoveries. But given what Polanyi writes about the disconnection between the two systems, one cannot infer from the truth of Copernicus the falsity of Ptolemy. Towards the end of *Personal knowledge* (p. 322), Polanyi raises the question: 'How can

[15] Further examples given by Polanyi (1958, pp. 12, 148–149) include de Broglie's ascription of wave characteristics to particles, and the falsity of the Newtonian conception of space as shown by Einstein.

we claim to arrive at a responsible judgment with universal intent, if the conceptual framework in which we operate is borrowed from a local culture…?'. He epitomises his answer: 'Believing as I do in the justification of deliberate intellectual commitments, I accept these accidents of personal existence as the concrete opportunities for exercising our personal responsibility' (Polanyi, 1958, p. 322).

As a response to cognitive relativism, most readers would judge Polanyi's answer as vapid and unconvincing.[16] Polanyi's analysis of frameworks and of logical gaps is strongly suggestive of relativism. As Gellner (1991, p. 201; emphasis added), in another context, wrote in summary of Lessing: '*from the inside*' different 'visions' ratify themselves. When supporters 'compete to vindicate their own faith, each endorsing his own, the charm only works *inwards*'. It seems likely that Polanyi's thesis of the logical gap between frameworks unwittingly opened the gates of metascience to the relativist forces that Kuhn and Feyerabend headed up.

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[16] Sanders (1988, pp. 205–206) writes that 'it is mainly on account of modern science and its concomitant naturalistic outlook, qualified by ideals like truth, justice and charity, that Polanyi takes our local culture as superior'. Sanders considers that in this way Polanyi avoids cognitive relativism. Other commentators (the present one included) would argue that the thesis of the logical gap provides no grounds for such comparative evaluation of conceptual frameworks as Sanders (mis)attributes to Polanyi.

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