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MICHAEL POLANYI AND THE PHILOSOPHY OF SCIENCE
The Viewpoint of a Practising Scientist

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1 INTRODUCTION

Before Michael Polanyi gave up his Chair in Physical Chemistry at the University of Manchester in 1948 in favour of his interests in social studies and philosophy, he was one of the world's leading physical chemists. He was a Fellow of the Royal Society and had already received several Honorary Degrees for his highly original researches into chemical reactivity[1]. He was of the category of chemists who could expect nomination for a Nobel Prize, an honour which his son John was later to receive. Of necessity therefore it was his experience as a scientist which underpinned much of his philosophy This was clear in his Riddell Memorial Lectures published as *Science, Faith and Society* in 1946, a decade before the publication of his philosophical *magnum opus, Personal Knowledge*. When I first came across PK I did not find it easy to read because of a lack of general philosophical background. However, perseverance led to its usual reward and I concluded that within PK there was, for me, the best account of the scientific endeavour to be found anywhere, an opinion reinforced by my later reading of *Science, Faith and Society*. However, Polanyi did not give an account of his philosophy of science which was altogether separate from that of his more general philosophical concerns. This has led to a situation where his contributions in this area are poorly acknowledged. For example a large volume entitled *The Philosophy of Science*, published in 1991, and edited by Boyd, Gasper and Trout[2], gave no reference to Polanyi in the index of authors. A subsequent scrutiny of the titles on my shelves concerned with this subject showed that only about half of them referred to Polanyi's work, and then sometimes with a single reference to PK. It therefore seemed worthwhile to provide a brief account of Polanyi's salient contributions to the philosophy of science and to discuss these in relation to the views of two other well known figures in this field, Popper and Kuhn. For those who are less familiar with these aspects of Polanyi's thought. his valedictory book with Harry Prosch entitled *Meaning*, and more recent accounts of his ideas, *Polanyi* by Richard Allen[3], and *Everyman Revived* by Drusilla Scott[4] provide introductions that some may find easier to read than the very detailed treatment given in PK.

2 POLANYI AND SCIENCE

2.1 *Judgement and Imagination: Personal Contributions with Universal intent*

In PK Polanyi consistently emphasises personal judgement and the personal use of imagination as central to scientific advances. Of course logic and rationality are also seen as of great importance, both in formulating enquiries and in evaluating the conclusions, but these are considered to be subsidiary to the achievement of conceptual advances through the use of judgement and imagination. As is normally the case with Polanyi, the use of the word 'personal' in this context is not to be interpreted in the sense of subjective, for such contributions are offered to the world-wide community of scientists for criticism and evaluation i.e. these personal contributions are to be made with 'universal intent'. It is perhaps the lack of an appreciation of Polanyi's restricted use of the word 'personal', relevant even to the title of his major work, that has led to some superficial misunderstandings of his position. Polanyi does not intend to contradict the widely-held view that a special feature of science is its capability of producing, perhaps uniquely, what others describe as objective or, perhaps better (see later discussion), reliable knowledge [5]. Research at the borders of science is an uncertain but purposeful activity, when different ideas can be put forward by different groups in a context of the continuing production of new evidence. Mere reliable conclusions are reached later when most avenues for the production of evidence have been explored. In due course a wide consensus is usually reached within that section of the international scientific community that is interested in the particular problem, although the consensus is always open to revision in the light of new evidence. Nothing is final and beyond criticism in science.

2.2 *Ethical and Fiduciary Aspects of Scientific Research*

Polanyi emphasises that the pursuit of science is far from a value-free activity, as is sometimes suggested to be the case by non-scientists, for it involves strong ethical and fiduciary-type commitments. The agreed aim of scienc e is to reach reliable understandings of the structures and operations of the natural world If this is to be achieved, it is essential for the individual scientist or group of scientists, to report their results freely, with truth and accuracy, and in such detail that others have sufficient information to be able to reproduce the experimental or theoretical processes that led to the proposed conclusions. Furthermore, on the way to the publication of results in a (preferably widely-circulated) journal, the author of a paper has to submit it to independent review and criticism under editorial judication.

Fiduciary elements include the universal conviction among scientists that, where the available techniques make it feasible to explore anew field of research, the results will ultimately be found to be rationally understandable in relation to the already-explored scientific world. Therefore in general scientists are critical realists (or scientific realists, to use the alternative phrase preferred by some philosophers). Polanyi emphasises that it is this belief in the rationality of the natural world, allied to an expectation that this will continue to manifest itself in ways of potential importance, that strongly motivates the scientist. A search for such clues, and the development of them into theories of generality that can provide further insights, is the essence of the scientific endeavour. Polanyi is opposed to the views of the positivist philosophers who regard scientific theories as merely convenient summaries of acquired information. One of them, Mach[6], for example, at the end of the nineteenth century urged that the atoms and molecules imagined by the chemists, being unobservable, should be considered to be just convenient mental concepts rather than to point to a real existence; today their reality is manifest through direct observation. According to Polanyi new theories should be assumed to have predictive potential as well as explanatory value, i.e. to have the capacity of thrusting forward towards future understandings. In his eyes science is a disinterested activity only in the sense that honesty and open-mindedness are essential in the search for new knowledge. Otherwise, as the spouses of most scientists know to their cost when their partner's work is going well, it is a passionate endeavour which consumes much time and energy and which demands strong commitment. In general Polanyi was much concerned to reinstate the human dimension into the public conception of science.

2.3 *The scientific community and the search for agreement*

A fine scientist, according to Polanyi, is one who has the ability to choose good problems in relation to the knowledge and exploratory techniques that are available at the time; to be skilled in what Medawar has termed 'the art of the soluble' [7]. To a degree this depends on the natural flair of an individual but, as described in some detail by Polanyi, for success it also requires a thorough previous education and training. This is in order that the novice can learn die methods and techniques applicable to his or her field of research and, equally important is taught how to relate to the scientific community as a whole. Science is a world-wide activity with expectations and general procedures common to all participants, whatever their country of origin. This is one reason why in the longer run no single individual of whatever eminence, can dominate a scientific field to the detriment of the acceptance of new ideas. Indeed scientific ideas develop with such rapidity that it is widely appreciated that persons who make fine contributions in their youth can often find themselves in a conservative stance in relation to new concepts. For example John Dalton, who is credited with the general adoption of the atomic theory of matter, could not agree to Avogadro's later hypothesis, very relevant to his field, that equal pressures of gases corresponded to the presence of equal numbers of molecules. The reason was that this implied that all the common gaseous elements were atomic in nature, a fact which Dalton considered to be most unlikely but which found clear explanation only some decades later after the monatomic rare gases were discovered.

2.4 *Scientific training. mutual traditions and authority in the scientific community; conviviality*

The principal feature of an undergraduate education in the sciences is that much effort has to be made in order to reach an in-depth understanding of the experimental and theoretical achievements of the chosen scientific field. Many laboratory, computational, and theoretical exercises are required in order to instil in the student a working knowledge of the science in question. Original investigations are usually only possible during the final undergraduate or the postgraduate years. This can cause frustration to those whose dedication to science is not of the strongest. The major effort required is necessary for the student to become strongly immersed in what Kuhn[8] later described as the prevailing scientific paradigm. Even then the guidance and supervision by a senior scientist is normally essential for the choice and successful conclusion of a research project. The senior colleague guides the student towards the most appropriate techniques, and for experimental work also often provides the equipment needed to further the investigation. Polanyi likens this phase to an apprenticeship of a young person to a master in the way practised in the past in art and today in architecture. In the process the young scientist acquires the necessary skills for subsequent independent research, becomes a knowledgeable recipient of the contents of the relevant literature, and learns how to make his or her own contributions to this. In other words, to use another of Polanyi's favourite terms, the requirement is to learn to become a connoisseur of the research field. In general this period provides an informal introduction to membership of the international scientific community and to its mutual traditions and authorities. It is an introduction to scientific 'conviviality', to use Polanyi's phrase; a term which implies mutual endeavour and trust within the community in question. Although well-established or traditional views can lead, as in non-scientific fields, to an initial reluctance to accept new ideas, the open and international nature of science ultimately enables even radical new ideas to take root once the supporting evidence is judged to be sound.

2.5 *Problem solving the Polanyi way*

The new researcher should ideally, in my experience, be introduced to Polanyi's recommendations for problem-solving, with its emphasis on the use of tacit as well as explicit knowledge accumulated during a person's lifetime of experiences. Where the problem is a difficult one that does not readily respond to further experimentation or to logical analysis, Polanyi's epistemological method involves repeated critical reviews of all the pieces of information deemed to focus on the problem, bearing in mind that some of these may prove to be false or misleading, while turning over in the mind various possible explanations. This is deliberately followed by a relaxed period during which the problem is little addressed in the hope that through the work of the subconscious a new idea will emerge, often suddenly, that allows the integration of earlier seemingly contradictory clues into a possible whole. The proposed solution has then, of course, to be put to observational or experimental test.

2.6 *Polanyi on reductionism*

When a phenomenon depends on several variables it is a standard procedure in experimental and observational science to look for situations where only a few of these vary at a time. This essential procedure is termed reduction, and from it an overall understanding of the phenomenon is more readily and logically obtained. The similar-sounding term *reductionism* has a different connotation and normally refers to the relationship between different levels of science, e.g. the relationship of physics to chemistry, or of physics and chemistry to biology. Physics is the fundamental experimental science and the others can be understood with its help. The nature of chemical bonding can, for example, in principle be understood in terms of the dynamic electromagnetic interactions between the charged particles (the negative electrons and the positive atomic nuclei) associated with the atoms to be joined together. In one sense it can therefore be said, adopting a reductionist attitude, that chemistry is nothing but physics. Another point of view is that chemistry deals with much more complex many-particle systems than physics aspires to, and that it is this complexity that is responsible for those additional phenomena which we characterise as typically chemical. If the former 'nothing but' attitude is characterised as reductionist, the greater interest in chemical phenomena as a whole represents the *holistic* attitude.

Polanyi's view is that the overall holistic picture is the more interesting (the more meaningful) one. Biological phenomena involve much more complex systems again and emerge from the interplay of that complexity with the physical and chemical principles that underlie them. He finds very unsatisfactory the description of biology as nothing but physics and chemistry. But he also says that matters go beyond personal preference, for he claims that in principle it is not possible to do this for any system that requires an operational principle for its understanding This applies not only to biological systems but also to machines and tools in general. Although this is a minority view, I am attracted to it and think that it may prevail. Of recent years there has been an increasing interest in the differences between the physical sciences, the principles of which are assumed to operate unchanged wherever or whenever they are applied and the sciences such as biology and geology, where a historical aspect is essential to overall understanding. I suspect that Polanyi's original but unconventional views on reductionism relate to that division, with engineering or technology also clearly falling into the 'historical' category.

2.7 *An overview of Polanyian science*

Polanyi's account sees science as a creative, passionate, humanistic and world-wide activity, thrusting forward towards new areas of understanding of the natural world. Many of the key steps in the process are, in his view, informal in nature and involve the applications of personal imagination and personal judgements; they are underpinned by logic and rationality wherever this is applicable. This is an account that I can strongly endorse from my own experience as a practising experimental scientist, although this is perhaps not too surprising as in many respects Polanyi's general philosophy is based on wider conceptual applications of the best practices within science. We have seen from

Section 2.6 above that Polanyi has also put forward challenging ideas for future evaluation. Although it is not appropriate to pursue the matter here, an additional great advantage of the Polanyi perspective is that it shows that the sources of creativity in the sciences and in the arts are essentially the same; that they differ only in the fields chosen for endeavour.

Next part

References

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Back to Contents