The Metaphysics of Science: An Account of Modern Science in Terms of Principles, Laws and Theories

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This book propounds an immensely important idea. Science makes metaphysical presuppositions. I must, however, at once declare an interest. For well over thirty years I have myself been expounding and arguing for just this idea.

Craig Dilworth argues that science is made up of three ingredients: metaphysical principles, theories, and empirical laws. There are three metaphysical principles: the principle of uniformity of nature, the principle of substance, and the principle of causality. Dilworth takes the first to assert that "similar states of nature are followed by similar states (p. 53), wherever and whenever they occur. The principle implies that space and time are homogeneous. The second principle asserts that substance is material and eternal, and "change is but an alteration of substance" (p. 55). Substance is to be interpreted in an open-ended way, so that it might be matter, field or energy. The third principle asserts that "change is caused" (p. 57). Putting the three principles together "we obtain the idea that causality acts regularly through the action of one portion of substance upon another, and that change consists in the relocation of substance" (p. 59).

These metaphysical principles are presuppositions of modern science but are not *a priori* in the sense that they are known with certainty. They are open to criticism, take on different forms for different scientific disciplines, and may be refined within a science. Thus, as far as physics is concerned, the principle of uniformity is refined to become invariance principles concerning spatial location, orientation and uniform motion, and time of occurrence; the principle of substance is refined to become the principle of conservation of energy; and the principle of causation is refined to become principles of dynamics, "the most fundamental of which is the principle of inertia: that a body will continue in its state of rest or uniform motion in a straight line unless acted upon by a force" (p. 64).

According to Dilworth, the three metaphysical principles constitute "the *core of modern science*" (p. 60). They influence science in at least four ways. They determine what is ontologically necessary or possible within a science. They provide the structure of scientific rationality. They guide research and provide methodological rules. And they define the basic concepts of science. This influence is exercised over both empirical and theoretical aspects of science. The task of theories is to explain empirical laws by revealing in detail how they exemplify the three principles.

Dilworth asserts "The novelty in the present view consists in the way the principles and their relation to the rest of science is conceived" (p. 71). This is false. Putting aside differences of vocabulary, emphasis and details, the view expounded by Dilworth is the same as a *part* of a view that I have myself defended some years earlier: see Maxwell (1974; 1976; 1984). It is odd that Dilworth does not acknowledge my earlier work. In four footnotes, he quotes approvingly from my (1984), three of these quotations actually

encapsulating aspects of the view of science in question. And yet there is not a whisper of an acknowledgement of my earlier work anywhere in Dilworth's book. [I should add that my (1974) and (1976) are referred to in Maxwell (1984)].

Dilworth and I employ different terminology. Dilworth calls presuppositionism (as we may call our common view of science) the "Principle-Theory-Law (PTL) model, whereas I call presuppositionism "aim-oriented empiricism" (AOE). There are also slightly more substantial differences. Whereas Dilworth puts forward *three* metaphysical principles of science, I put forward *one*, which I call *physicalism*. This asserts that the universe is physically comprehensible. More specifically, it asserts that "the world is made up of only a very few different sorts of things (atoms, point-particles, fields or whatever) which change and interact in only one, precise, fixed way. That which does not change, X, precisely determines the manner in which that which changes, Y, does change (both X and Y being properties of the basic physical entities out of which everything is composed)" (Maxwell, 1984, p. 219). Put another way, "modern natural science presupposes that there exists some kind of unified pattern running through all natural phenomena, it being a basic *aim* of physics to articulate this pattern as a testable, comprehensive, unified theory" (Maxwell, 1984, p. 96; see also pp. 218-31). Physicalism as I characterize it is close, even if not identical, to Dilworth's three principles. What is striking, however, is that their metaphysical character, their epistemological status, and the influence they exert over science *are* all but identical in the two views.

Dilworth intends his (unrefined) three principles, when variously interpreted, to be presuppositions of *all* branches of modern science – not just physics, but chemistry, geology, biology, and even social sciences such as economics. This is not very plausible. Dilworth takes life to be the substance of biology, but life is neither eternal nor conserved (as the principle of substance requires). Both biology and geology have an essential *historical* dimension, which ill-accords with the three principles. Dilworth attempts to show that economics presupposes his three principles (appropriately interpreted), but I found this attempt unconvincing.

AOE is free of these defects. Physicalism is taken to be the presupposition of *physics*, and therefore of all of natural science (physics being the fundamental natural science). Other disciplines of natural science can then make more specific presuppositions, particular to each discipline, as long as these are taken from, or are sufficiently in accordance with, results of more basic sciences, and ultimately of physics. Thus chemistry can assume that mass is conserved in chemical reactions because physics tells us this is nearly enough the case. Viewing natural science as an interlinked whole in this way frees one of the need to specify the same kind of presuppositions for all branches of natural science. One can see geology, for example, as accepting results from physics and chemistry but nevertheless having an aim quite different from either, in that it seeks to acquire knowledge of the structure and history of a particular object – the Earth.

Above I said that Dilworth's PTL model is all but identical to a *part* of my AOE; I said this because AOE, in a number of ways, further develops the common basic idea of presuppositionism. Here are nine deficiencies in Dilworth's account, deficiencies made good in my (1984) – and in my (1976) and (1974).

First, Dilworth fails to provide what is, in my view, the basic *argument* in support of presuppositionism. This is that physics only ever accepts *unified* theories, even though endlessly many disunified rivals can always be concocted that are just as, or even more,

empirically successful. This persistent acceptance of unified theories only, even though endlessly many empirically more successful disunified rivals are available, means that physics persistently assumes that there is some kind of underlying dynamic unity in nature – the metaphysical thesis of physicalism (Maxwell, 1984, p. 96 and pp. 206-246; 1976, p. 75-6; 1974, pp. 125-36).

Second, as a result of failing to put forward this (or any other) argument in support of presuppositionism, Dilworth fails to explicate adequately the metaphysical presuppositions of modern science. The above argument makes clear that the key idea is dynamic *unity* in nature – the universe being such that the true physical theory of everything is more or less *unified*. Dilworth's three principles do not contain or imply unity. Lacking the above argument, Dilworth fails to appreciate the key role played by unity (for which see Maxwell, 1984, pp. 96-100 and 218-225; 1976, pp. 75, 107-110; 1974, pp. 129, 140-141, and 264-294).

Third, Dilworth fails to stress the profoundly *problematic* character of the metaphysical presuppositions of science, and thus fails to emphasize that these presuppositions, because they are problematic and exercise a profound influence over science, need to be made explicit within science, so that they can be critically assessed, alternatives being developed and assessed in the hope of *improving* the metaphysical assumptions made by science. For these points see (Maxwell, 1984, pp. 96-100, 110-117 and 223-246; 1976, p. 65 and 69; 1974, pp. 249-254).

Fourth, Dilworth does not appreciate that physicists *fail* to make explicit and criticize metaphysical presuppositions of physics because of their allegiance to an untenable doctrine I call *standard empiricism* (SE). According to SE, the basic aim of physics is truth, the basic method being to assess claims to knowledge with respect to empirical success and failure (and perhaps considerations of simplicity and unity), *no persistent metaphysical assumption being made by science*. SE implies that metaphysics cannot be a part of scientific knowledge (unless implied by current knowledge). Taking SE for granted, physicists are, as a result, debarred from performing the vital scientific task of criticizing and improving relevant untestable, metaphysical assumptions (see Maxwell, 1984, pp. 98-100; 1976, pp. 58-61 and 63-64).

Fifth, Dilworth does not realize that it is not just the views of philosophers of science that need to change; science itself needs to change. If science is to be pursued rigorously, SE needs to be repudiated by the scientific community, and AOE needs to be accepted and put into scientific practice instead. This involves at least shaping science so that there are three levels of discussion: (1) empirical data; (2) theory; and (3) metaphysical assumptions or aims (see Maxwell, 1984, pp. 97-100, 231-245; 1976, p. 103-110; 1974, pp. 249-257 and 288-291).

Sixth, Dilworth fails to see that, in order to facilitate criticism and improvement of (3), science needs to represent its assumptions or aims in the form of a hierarchy, assumptions becoming less and less substantial, and more nearly such that their truth is required for science, or the pursuit of knowledge, to be possible at all, as one goes up the hierarchy. In this way, a framework of relatively unproblematic, stable assumptions and associated methods is created, high up in the hierarchy, within which much more substantial, specific and problematic assumptions and associated methods, low down in the hierarchy, can be effectively criticized and *improved*, as science proceeds. Assumptions low down in the hierarchy, from the history of physics, include such ideas

as that everything is made up of corpuscles interacting by contact, point-atoms interacting by means of forces at a distance, a unified, classical field, quantum particles, a unified quantum field, quantum superstrings. According to AOE, that assumption is to be (provisionally) accepted which (a) best accords with physicalism and (b) sustains the most empirically progressive research programme, or holds out the best hope of such a programme: see Maxwell (1984, pp. 232-235).

Seventh, having failed to develop this hierarchical view, Dilworth naturally fails to see that it leads straight to a new conception of scientific rationality. For, according to AOE, as scientific knowledge improves, so the (low-level) assumptions and associated methods of science improve as well; the aims and methods of science improve or, as one may put it, knowledge-about-how-to-improve-knowledge improves. There is something like positive feedback between improving knowledge and improving knowledge-about-how-to-improve-knowledge – a feature of scientific meta-methodology which helps explain the explosive growth of scientific knowledge (see Maxwell, 1984, pp. 231-242).

Eighth, Dilworth does not realize that this transforms science into something rather close to the natural philosophy of Newton's time, in that science includes sustained discussion of metaphysics, aims and methods, philosophy of science and epistemology (see Maxwell, 1984, pp. 231-240; 1976, pp. 53-63, 67, 79-80, 82 and 103-110; 1974, pp. 288-291).

Ninth, Dilworth ignores that science does not just seek explanatory truth – truth presupposed to be explanatory; more generally, it seeks *important* truth. Values, of one kind of another, are inherent in science. But, for all sorts of reasons, value assumptions are almost more problematic than metaphysical assumptions. If science is to be rational, and if it is to serve the best interests of humanity, it is essential that conjectures about what it is of value to discover, and what it is scientifically possible to discover, are articulated and critically assessed, as an integral part of science, to give us our best hope of discovering what is both of value and discoverable. Furthermore, science seeks valuable truth so that it will be used by people, ideally in beneficial ways. This social or humanitarian aim of science is, if anything, even more problematic. Once again, if science is to be both rational and serve the best interests of humanity, the problematic humanitarian or social goals of science need to be articulated and critically assessed: see Maxwell (1984, pp. 100-117 and 152-166; 1976, pp. 52-158).

I might add that since the publication of the first edition of the book under review, there have been further developments in AOE which Dilworth might have taken note of for this second edition. In Maxwell (1998) in particular, I develop the hierarchical aspect of AOE further, and show how the problem of induction, and problems concerning the unity of physical theory can be solved within the framework of AOE.

This second edition of *The Metaphysics of Science* is unchanged except for three additional chapters, one discussing the problem of demarcating science from non-science, one responding to critics of the first edition, and one arguing forcefully that technological innovation is leading humanity towards catastrophe. Dilworth suggests that we need a new metaphysical paradigm for a new kind of science. He seems not to have noticed my argument that what we really need is a revolution in academic inquiry so that the basic aim becomes to seek and promote wisdom rather than just acquiring knowledge – wisdom being the capacity to realize what is of value in life, thus including knowledge, but much else besides (see Maxwell, 1984).

Despite these criticisms, I would like to reiterate the point with which I began: this book propounds an immensely important idea – even if one that received a much improved formulation at least twelve years before publication of the first edition.

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