THE DISORDER OF THINGS

Metaphysical Foundations of the Disunity of Science

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Contents

Introduction

Science and Metaphysics

This book has two interwoven theses. The first concerns science. It is the denial that science constitutes, or could ever come to constitute, a single, unified project. The second is metaphysical, a thesis about how the world is. This thesis is an assertion of the extreme diversity of the contents of the world. There are countless kinds of things, I maintain, subject each to its own characteristic behavior and interactions. In addition, I propose a relation between these two theses: the second shows the inevitability of the first.

As my topics are the philosophy of science and metaphysics, so my argument will draw eclectically from science, philosophy, and common experience. Despite some skeptical notes about parts of science, I place myself firmly in the philosophical tradition that sees empirical, often scientific, inquiry as providing the most credible source of knowledge of how things are. In contrast to most related endeavors, however, I shall draw primarily not on physics, but on biology. Biology is surely the science that addresses much of what is of greatest concern to us biological beings, and if it cannot serve as a paradigm for science, then science is a far less interesting undertaking than is generally supposed.

It is now widely understood that science itself cannot progress without powerful assumptions about the world it is trying to investigate, without, that is to say, a prior metaphysics. Aristotle's picture of the natural ordering of basic substances in concentric circles and Newton's vision of a universe of massive objects moving through an infinite void were not the products of empirical

inquiry, but sets of assumptions that proved among the most fruitful in history in suggesting strategies of investigation and in interpreting the results of those investigations. Such assumptions, concerning such matters as the unity or diversity of the world's ultimate contents, or the nature and prevalence of causality, are the kinds of questions I take to be in the domain of metaphysics. The metaphysics of modern science, as also of much of modern Western philosophy, has generally been taken to posit a deterministic, fully law-governed, and potentially fully intelligible structure that pervades the material universe. The rejection of this set of assumptions is what I mean by "The Disorder of Things."

Given the dependence of science on metaphysics, it might be thought that the examination of science for metaphysical insights constitutes a *petitio principii*. The reason I deny this conclusion is that whereas I accept the dependence of scientific inquiry on a complex body of fundamental presuppositions, I also claim that empirical inquiry (which I do not limit to scientific inquiry) provides the evidence on which such assumptions must ultimately rest. Thus I claim that founding metaphysical assumptions of modern Western science, most notably those that contribute to the picture of a profoundly orderly universe, have been shown, in large part by the results of that very science, to be untenable.[1] And this, in turn, shows the impossibility of a unified science. I also want to argue, in the final part of the book, that these conclusions matter, that there are political as well as philosophical issues at stake in these questions about order and unity.

The Refutation of Essentialism, Reductionism, and Determinism

The best way to introduce the position against which this book will argue is to consider the continuing influence of one particularly notorious founding metaphor of modern science, the idea that the universe should be considered as a gigantic machine. Traditionally the favored machine has been a clock. Although the metaphor is naturally associated with a clockmaker, as in William Paley's famous argument for the existence of God, latter-day mechanists have deprived the clockmaker of no more than his sight.[2] Anyone who thinks that such mechanical metaphors have faded

in significance might reflect on the amount of scientific effort that has been devoted in recent years to investigation of the hypothesis that the human brain—and generally also the human mind—is really a kind of calculating machine, or computer.[3]

The philosophical thesis most intimately connected with this mechanistic metaphor is determinism. The cosmic clock, we must assume given its provenance, has always told the correct time and always will. To achieve such precision its components must exhibit the same unvarying reliability as the whole. Once the clock is wound up and set in motion, its behavior and that of all its parts are determined for all eternity.

It is true that the contemporary cosmic clock has become complex beyond any possibility of full human comprehension. Indeed the current vogue for chaos theory suggests that certain aspects of this complexity may be in principle beyond the reach of certain kinds of comprehension, notably prediction. Nevertheless, the metaphysical conceptions of order that originated in the picture of the mechanical universe seem to have been little threatened, if sometimes modified, by such developments. The case of chaos theory nicely illustrates this resilience. Prediction, though long conceived as a very central excellence of scientific understanding, is a goal that has tended to recede rather than approach as various scientific disciplines have increased their understanding of the complexity of the phenomena within their domains. Chaos theory appears to confront prediction not merely with an insuperable practical difficulty, but with a logically impassable obstacle. Yet paradoxically determinism, the metaphysical underlay of the possibility of prediction, is strengthened rather than threatened by this development. For the central mathematical functions of chaos theory are quite deterministic. They serve to show that it was a mistake to assume that, in a deterministic universe, even Laplace's demon could predict the evolution of events. Even the increasing prevalence of probabilistic rather than deterministic hypotheses and methods from quantum mechanics up through the scientific hierarchy has not, I shall argue, led to the rejection of some of the most fundamental features of the deterministic world view.

Arguments against determinism, however, come at the end of

my exposition, approached by way of a rather more subtle aspect of the mechanistic paradigm, reductionism. The way to understand the behavior of a machine is first to understand the behavior of its component parts, and then to see how the interactions of those parts generate the behavior characteristic of the whole. For a complex machine this task may need to be carried out in a number of stages. Thus we might understand a car, in the first instance, as consisting of engine, gearbox, steering assembly, starter, brake system, and so on. Each of these would be subject to further structural analysis, and after a very few steps we would reach relatively simple parts with simply intelligible mechanical properties.

This picture of successive understanding in terms of a hierarchy of ever smaller and simpler structural components is generally referred to as reductionism and has been a dominant ideal of modern science. Reductionistic accounts of science can be developed in various ways. My elementary illustration suggests a hierarchy of kinds of objects. A more familiar philosophical interpretation of reductionism involves a hierarchy of theories, each of which is, ideally, derivable from a theory of simpler entities and some postulated identities between the entities of the first theory and structures of entities of the second theory. This position is often referred to as theory reductionism. It will be apparent that such a thesis suggests a strongly ordered and global structure to the universe. Theory reductionism seems to imply that in principle all our understanding of everything should be derivable from our understanding of the smallest structural components of the universe (assuming, at least, that any such smallest components exist). For this reason, since this would amount to the subsumption of all of science by the science of the microphysical, theory reductionism has become widely identified with the unity of science. The thesis also has strong affinities and connections with determinism. In particular, a deterministic account of the smallest constituents of things, classically a mechanistic story about minute and elastic atoms, will transmit its deterministic properties to the structures composed of those things.

One final philosophical doctrine that I identify as central to the mechanistic world view is essentialism. In contemporary philos-

ophy this is most naturally approached through theories of natural kinds. According to such theories, one fundamental kind of facts, over and above facts about what individual things there are, are those concerning what *kinds* of things the world contains. To say that iron or humans form natural kinds is to claim a kind of objective legitimation for our divisions of things into those that are and are not ferrous or human. This idea is also related to mechanism. The fact that something is a car more or less determines what its constituent parts are and to what kinds they belong. Pistons and sparkplugs are proper parts of cars in a way in which that part of the engine block that still has its original paint, say, is not. Even more diffuse things can be distinguished, such as the cooling system. The radiator and the water pump are objectively part of the same constituent of the car in a way that the distributor cap and the cigarette lighter are not. The parts of cars form a determinate hierarchy of kinds. If the world is a machine, it is reasonable to suppose that the parts of the world do likewise.

In contrast with both determinism and reductionism, I do not doubt that a weak version of the doctrine of natural kinds is defensible. That there are objective divisions between some distinct kinds of things would be hard to deny. Indeed, I shall argue that there are many more such divisions than is generally allowed. What I do want to deny, and what is suggested by the embedding of an account of natural kinds in the context of mechanism, is the idea that it is a generally appropriate and tractable question to ask, of an object, What is the natural kind to which it belongs? I claim, on the contrary, that such questions can be answered only in relation to some specification of the goal underlying the intent to classify the object. In relation to an account of the workings of a car, it is quite straightforwardly true that a particular constituent object should be classified, for example, as a piston. This classification correctly identifies the (sole) function of this constituent in the overall economy of the larger system the car. But the unambiguousness of this identification is clearly relative to a particular context, the context defined by the overall function of the car. And it is quite possible for the career of the piston to exceed its tenure in the car and to continue as a hammer or a weapon. Since the world is not a machine, nature does not generally provide

contexts that can serve to determine unambiguously the kinds to which objects belong, and such context must typically be provided instead by the goals of a particular investigation.

The idea that things belong to unambiguously discoverable natural kinds is intimately connected with the commitment to essentialism. Essentialism connects with conceptions of natural kinds through the idea that what makes a thing a member of a particular natural kind is that it possesses a certain essential property, a property both necessary and sufficient for a thing to belong to that kind. The essential property is thus admirably suited to provide an objective feature which can answer the question, independently of any context of inquiry, To what kind does this thing belong?

These various issues concerning classification are ideally addressed in relation to biology. Classification has always been a central task of biology, and biological classification is a significant part even of prescientific language. As I shall argue in Chapters 1 and 2, biological classification provides no encouragement to essentialism. Not only does essentialism fail in biology, but it can be argued that there is not even a unique set of kinds into which biological organisms should ideally be sorted.

The main body of this book will be occupied with detailed critiques of these three doctrines—determinism, reductionism, and essentialism—which constitute the central pillars of a classical conception of cosmic order. At the same time, I shall develop some ideas about what a universe lacking the order implied by these doctrines must be like. Partly to develop more perspicaciously the positive views, and partly because it seems the clearest way to present the argument, I shall discuss them in the reverse order of that in which I have introduced them here. Although my decision to begin with a discussion of kinds and essentialism might seem eccentric to a reader focused on the history of discussions of scientific unity, my views on these topics provide the natural starting point for explaining the alternative to the classically ordered universe that I propose. The most general positive doctrine I shall advocate is pluralism: first, in opposition to an essentialist doctrine of natural kinds, pluralism as the claim that there are many equally legitimate ways of dividing the world into kinds, a

doctrine I refer to as "promiscuous realism";[4] and second, in opposition to reductionism, pluralism as the insistence on the equal reality and causal efficacy of objects both large and small. These pluralisms make determinism almost impossible to sustain. Only a privileged and restricted set of entities and kinds could make it plausible that everything could occur in accordance with a unified and universally applicable set of principles. I shall claim, on the contrary, that in the pluralistic universe that I take to be ours, causality is a much more scattered and variable feature.

The Disunity of Science

The idea of science as a project that might ultimately be completed in some grand synthesis of all natural knowledge is an understandable and perennial dream. The greatest scientist of the twentieth century, Albert Einstein, was a notorious believer in unification and simplicity as fundamental goals of science. He is quoted, for instance, as remarking: "What really interests me is whether God had any choice in the creation of the world."[5] Some of Einstein's greatest achievements have been attributed to his search for unifying principles; on the other hand, much of his later life was devoted to what is now seen as a fundamentally misconceived quest for a unified field theory. At any rate, if the world is as I have just briefly described it, then the dream of an ultimate and unified science is a mere pipe dream. A number of philosophers, perhaps a majority, have become skeptical of strong doctrines of scientific unity in recent years. But this skepticism has generally derived not from doubts about the traditional metaphysical underpinnings of a possible unified science, but from the recognition of insuperable pragmatic obstacles to its development: the cosmic clock has proved too complex for complete analysis by humans. Apart from endorsing and defending this skepticism, my goal is to anchor that skepticism in a more appropriate metaphysics. Thus my thesis will be that the disunity of science is not merely an unfortunate consequence of our limited computational or other cognitive capacities, but rather reflects accurately the underlying ontological complexity of the world, the disorder of things.

Concerns with the unity of science have a long history. The

expression "unity of science" is most widely associated with the Vienna circle and with logical positivism, and the epistemological monopoly of science that it is one of my major goals to criticize here was perhaps most unproblematically assumed by that philosophical school. However, for a number of reasons I shall not attempt to trace the issues I address to their roots in that source. First, and perhaps most fundamentally, a central defining characteristic of logical positivism was the rejection of metaphysics. This book, as its title declares, is intended to be metaphysical through and through. Second, the resurgence of metaphysics can be seen in the transmutation of one of my central topics, reductionism, the doctrine most generally associated with the unity of science. For classical positivism, reductionism refers to the attempt to ground knowledge entirely in the simplest possible observation statements, so as to eliminate any dubious inferences beyond the observable. This is the project of Rudolf Carnap's *Aufbau* (1928), the project perhaps best known from W. V. O. Quine's assault on it in his classic paper "Two Dogmas of Empiricism" (1951). The conception of unified science that derives from this project has now been long abandoned. It is, at any rate, far removed from the reduction of scientific theories to theories of the microphysical, which is the topic of a substantial proportion of this book. Whereas positivist reduction is strictly and intentionally epistemological, contemporary theory reduction, presupposing a structural hierarchy down to microphysics, is thoroughly ontological. Indeed, the microphysical, the basis for contemporary reductionism, was the primary object of positivist epistemological suspicion, and the main target of reduction to the observable.

The distance of contemporary ideas on the unity of science from those of the Vienna circle is even clearer in the light of recent work by Jordi Cat, Hasok Chang, and Nancy Cartwright (1991, 1992) on Neurath's conception of unified science. Otto Neurath, generally considered as the leader of the unity of science movement, appears to have been explicitly opposed to any kind of physicalist *or* sensationalist reduction.[6] Indeed Cat, Chang, and Cartwright (forthcoming) suggest that he held a pluralistic attitude to science very similar to the one that I defend. For Neurath, the point of the unity of science was just that particular practical

problems may require input from many different parts of science for their solution, and all the parts of science should therefore be jointly applicable to the same question. The *Encyclopaedia of Unified Science* was not to be a systematic text, but a toolkit of scientific devices. The importance of this point of view, in turn, can be traced to Neurath's enthusiasm for, and practical involvement with, attempts to establish centralized socialist states, both as a participant in the unsuccessful socialist uprising in Bavaria in 1919, and subsequently as connected with the socialist government of Vienna from 1919 to 1934 (Cat, Chang, and Cartwright, forthcoming).[7]

For all of these reasons, for one, like myself, concerned with contemporary debates about the unity of science, the texts of classical positivism are of only marginal relevance. There are, of course, important threads that could be followed from the work of Carnap, Moritz Schlick, Neurath, and others to present-day concerns. But such historical exploration is not among my aims. While the ghosts of innumerable ancestors undoubtedly walk through any philosophical text, the ancestors I shall directly engage are recent ones.[8] Quite specifically, the starting points for the conversations in which I see myself as engaged are mostly around the 1950s and early 1960s. This post-positivist but pre-Kuhnian watershed in the philosophy of science, marked by classics such as Ernest Nagel's *The Structure of Science* (1961) (the benchmark for contemporary discussions of reductionism) and C. G. Hempel's *Aspects of Scientific Explanation* (1965), represent the high point of sophisticated and shared optimism about the rationality, coherence, and value of science.

Since then, in substantial part as a result of the influence of Thomas Kuhn, things have fallen apart. My present concerns are with various fragments of this disintegration. One set of fragments comprises the thriving areas of philosophy of science that have avoided questions about science in general by focusing on problems peculiar to specific scientific disciplines. Especially prominent are the philosophy of physics and the philosophy of biology; several of the following chapters engage mainly with work that has come out of the latter field. In a more general way, the philosophical views of many of the leading philosophers of the

last several decades reflect the influence of both positivist and post-positivist philosophies of science. Quine, one of the most influential critics of positivism, retains an exclusive role for science in ontology that I would consider insupportable. Donald Davidson's views in the philosophy of mind, though explicitly intended as antireductionistic, rest, I argue in Chapter 7, on a metaphysics that is entirely and unacceptably reductionistic and deterministic. In the philosophy of science aspects of post-positivist or even positivist views of science can be found everywhere, though generally not united in the works of any one philosopher. Many philosophers of science, indeed, still adhere to some doctrine of scientific unity, though often doctrines rather different from those I have mentioned, proposing, for example, unity of method or of process. Some of the most important such doctrines will be considered in Chapter 10. One of my aims, then, is to clear away some of the remaining debris of a philosophical movement that, though largely abandoned some decades ago, continues to exercise a powerful influence over major areas of philosophy.

I shall, finally, offer some constructive if sketchy suggestions about how to think of science in the absence of unity. Given that there may be little common to all the various activities or systems of belief that coexist under the conceptual umbrella of science, I shall propose that science is best seen, in Wittgenstein's valuable phrase, as a family resemblance concept. Many features are common to many sciences, but no set is definitive of any adequate science. This will be recognized as an application to science of the antiessentialism that I shall defend for nature. In accordance with this parallel, and rejecting the possibility of any single criterion that constitutes a body of belief as scientific and hence epistemically acceptable, I also advocate epistemological pluralism. While I am reluctant to advocate the extreme tolerance of Paul Feyerabend (1975)—I have stronger prejudices against astrology, theology, and even alchemy—I would certainly reject the dogmatic monotheism of much contemporary philosophy of science: there are surely paths to knowledge very different from those currently sanctioned by the leading scientific academies. In pursuit of this idea, I would like to suggest that rather than seeking a criterion of scientificity, we should attempt to develop a catalogue of ep-

istemic virtues. Some of these will flow naturally from the philosophical tradition: empirical accountability, consistency with common sense and other well-grounded scientific belief, and perhaps the more aesthetic virtues such as elegance and simplicity. More recent conceptions of science suggest that these must be supplemented with more straightforwardly normative virtues. Investigation of the androcentric and ethnocentric biases of much science suggests, for example, a fundamental desideratum of democratic inclusion and accountability.[9]

Critical Perspectives on Science

As can be inferred from my skepticism about the unified project of science, my goal is not to provide a general criticism of the aspirations or achievements of science. For such a project presupposes that some entity—science—exists to be identified and criticized. And while there may perhaps be a genuine *sociological* object identifiable as the referent of "science," it is obvious that this would be quite inadequate to capture the concept assumed in most philosophy of science both traditional and contemporary. To mention only the most obvious point, science is generally taken to have some more or less privileged claim to truth. Yet there are large areas of science in the sociological sense that, at least to the casual glance, have at best highly questionable claims to truth or credibility. One reason why it is important to dispose of the myth of scientific unity is that one might, in principle, judge that macroeconomics or mathematical population genetics, say, has claims to credibility on a par with palmistry or tarot reading, without being committed to making the same claim about mechanics or immunology.

Skepticism about cosmic order should raise doubts not only about the unity of science but also about its universality. Since science does, presumably, presuppose some kind of preexisting order in the phenomena it attempts to describe, limits to the prevalence of order may entail limits to the applicability of science. Some areas of science may fail because the subject matter is inhospitable to scientific methods. A particularly interesting possibility of this kind is that there might be large parts of the human