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PHILOSOPHY OF SCIENCE IN THE TWENTY-FIRST CENTURY

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Abstract: Philosophy of science in the past half century can be seen as a reaction against logical empiricism's focus on modern logic as the format in which debates should be expressed and on physics as the canonical science. These reactions have resulted in a fragmentation of the field. Although this provides ways forward for disparate philosophies of various sciences, it threatens the very possibility of general philosophy of science. The debate that most obviously continues to be conducted at the general level—the debate about scientific realism—only does so because of a dangerous naïveté. Nevertheless, this article suggests that there is a place for general work not by starting at the highest level of abstraction but instead by abstracting general lessons from actual science.

Keywords: philosophy of science, history of philosophy of science, general philosophy of science, scientific realism, disunity of science, the future of philosophy.

Philosophy of science in the United States, at the middle of the last century, was primarily logical empiricism. From an internal point of view, this was a response to two dramatic developments: modern logic and revolutionary physics.

The first (modern logic) had dramatic effects in every area of philosophy. Anything important was translated into expressions in a formal language.

The second (modern physics) was important primarily for philosophy of science. Newtonian mechanics, which had been the paradigm example of established science, was overthrown by relativity and by quantum mechanics.

Enough time has passed that philosophers writing about Carnap and Quine now count as writing the history of philosophy. I am going to tell an imprecise and idealized story: the past half century in philosophy of science can be seen as a reaction against these two earlier influences.

1. Logic as the Language for Philosophy

For the logical empiricists, theories were sets of sentences in a formal language. This Received View of theories succumbed to serious criticism

in the 1960s. Opponents developed the semantic conception of theories, according to which a theory is a set of models. In early formulations of the semantic conception, this meant formal models: abstract semantic structures. Subsequent philosophers have been more permissive about what may count as a model, allowing in drawings and physical scale models.

As things stand now, I do not think that there is a consensus about what theories are or how they may best be represented. The most appealing position, I think, is theory category pluralism. This is the view that there is no single correct conception of "theory." Instead, there are several equally legitimate conceptions of the category theory that are useful for different purposes.

2. Physics as the Paradigm Science

It is no longer the case that philosophy of science and philosophy of physics neatly coincide. Philosophers take the special sciences seriously.

This is reflected in the structure of the profession. Many departments look to hire specialists. There are specialist journals for philosophy of biology, philosophy of psychology, philosophy of chemistry, and so on.

The difference is also substantive. Some of the questions asked by philosophers of a special science may have little relevance for philosophers of other sciences. For example, much has been written about the question of what "fitness" means in the theory of natural selection. This is a foundational question for evolutionary biology, and philosophers have had helpful things to say. Yet our understanding of other sciences, or of science generally, has nothing to do with what we say about "fitness."

At the same time, philosophy of physics has become its own autonomous specialty. Technical questions about how to reconcile relativity with quantum mechanics, for example, have no more relevance for the philosopher of biology than "fitness" has for the philosopher of physics.

So are there any questions left for general philosophy of science, rather than the philosophies of the special sciences? In the next section, I consider the obvious candidate: scientific realism.

2.1. Scientific Realism

Scientific realism, roughly, is the view that our best scientific theories accurately represent both the observable and the unobservable world. More precisely, it is the view that our mature theories are approximately true.

By the 1970s, philosophers of science had come to accept that there was no principled difference between vocabulary that identifies observable

entities (like "tree" and "chair") and vocabulary that identifies theoretical entities (like "atom" and "electron"). One might express this lesson, as Quine did, by saying that trees and atoms are all posits introduced to make sense of our experience—the words "tree" and "atom" are both, in some sense, theoretical. At the same time, he said that we should look at our best science and believe in whatever entities are posited in its theories. So atoms are just as real as trees. As such, after the demise of antirealist logical positivism, many philosophers were scientific realists.

In the past few decades, even most antirealists have accepted that words like "atom" refer to atoms, just as "tree" refers to trees. They have insisted, nevertheless, that we should believe in trees but not in atoms; that is, we should believe in the observable parts of our theories but not in the unobservable parts.

For Bas van Fraassen, whose book *The Scientific Image* was published in 1980, antirealism is closely connected with the shift to the semantic conception of theories. The distinction between the observable and the unobservable is a distinction to be made not between two kinds of vocabulary, according to van Fraassen, but instead between two kinds of thing; that is, the models of a theory are divided into observable and unobservable parts.

Debates about scientific realism have generated a massive literature. Since general philosophy of science is about scientific theories generally, rather than theories in physics or biology especially, one might conclude that it is alive and well.

This would be too quick, I think. Despite realists' claims that the theories in our mature sciences are approximately true, realism is simply more appealing for some sciences than for others. Take two examples:

A. The theory of plate tectonics would be perverse if there were not actually tectonic plates moving very slowly across one another. Even though we cannot apprehend this motion with our unaided senses, it is hard to imagine accepting plate tectonics without believing in continental drift.

B. The entities posited in particle physics are more exotic. One can imagine accepting particle physics and using it for practical purposes without actually believing in, for example, the top quark.

So the question of scientific realism is not one that can be decided for science *simpliciter*. Perhaps we should believe in some of the unobservable entities posited by our best scientific theories but not in others.

The opposition between scientific realism and antirealism cannot be settled for all or most of science by a master argument. It can only be settled for particular theories by particular arguments. Determining whether or not we should be realists about black holes, for example, does not settle whether we should be realists about genes. One might worry that these determinations just become a matter of doing science, rather than doing philosophy at all.

2.2. The Disunity of Science

In the late 1980s and 1990s, some philosophers of science argued that there is no such thing as science *simpliciter*—there are just many different sciences. This "disunity of science" position was partly a reaction against the attitude, discussed earlier, that physics is the paradigmatic science. (The essays in Galison and Stump 1996 showcase this movement.)

When physics was taken to be the exemplary science, it was common to think along these lines: The correct account of the world is the one given by physics. Biology, then, must just be a simplified summary of the physics that goes on in organisms. Psychology must just be a simplified summary of what is happening at the biological and so ultimately physical level. And so on. Everything must reduce to physics, at least in principle.

Yet philosophers of biology found that reduction doesn't seem to be possible, even in principle. Does this make biology unscientific? Only if science must provide a unified, hierarchical picture of the world. If we take as a premise that biology is scientific, then the failure of reduction means that science does not provide a unified picture of that kind.

The claim of disunity suggests that there might not be any room for general philosophy of science, as opposed to philosophies of special sciences.

3. Is There Any Philosophy of Science Left?

Of course, I think general philosophy of science is possible. Most of the articles I have published are about science generally, rather than just about physics, biology, or information technology— although I have used examples from all these areas.

Consider a physicist describing the projectile motion of a cat as it's thrown through the air and a biologist describing the metabolism of the cat. They are, of course, describing the same cat. The various sciences, although not perfectly unified, are not entirely separate. They give accounts of the same world. So it would be weird if there were nothing general that could be said about science.

So we strive to make our arguments as general as possible, while acknowledging that no single argument can tell us what must be the case for all of science. The challenge for philosophy of science is resisting the appeal of naïve abstraction while working at a greater level of generality than the specific sciences.

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