INTRODUCTION TO PHILOSOPHY

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TOPIC 8
PHILOSOPHY OF SCIENCE

- Philosophy of science is effectively *applied* philosophy, in that we are raising philosophical issues within a particular domain.
- Often, however, the kinds of philosophical issues that are raised by science take us right to the heart of core philosophical topics like metaphysics, philosophy of mind, and epistemology.
- In this segment of the course we will examine what constitutes a scientific inquiry, and ask whether science gets us closer to the truth.

THE SCIENTIFIC AND THE MANIFEST IMAGE

- The American philosopher Wilfrid Sellars (1912-89) drew a useful distinction between the *manifest image* and the *scientific image*.
- The manifest image is the generally shared worldview we have that is uninformed by science, such as that dark clouds are a sign of rain, or that tables and chairs are solid objects.
- In contrast, the scientific image is a worldview that is informed by science, such as that tables and chairs in fact contain more space than matter, or that there are more physical dimensions to reality than those we encounter in experience (or even that the earth orbits the sun rather than vice versa).
- The point is that the scientific image of the world is often in conflict with manifest image.

Wilfrid Sellars
(1912-89)

SCIENCE AND OBSERVATION

- ❑ Scientific inquiry is primarily empirical, in that it proceeds by making inquiries about the world around us via observation.
- ❑ It then constructs theories to account for the empirical data that these observations generate.
- ❑ Sometimes these theories might well appeal to theoretical entities which are *unobservable*. (Consider the example I gave earlier, of there being more dimensions than we can experience). What is the status of these unobservable entitles?
- ❑ According to one influential programme in the philosophy of science, known as *logical empiricism*, we should reduce all scientific talk of theoretical entities to observation reports, and in this way eliminate unobservable entities from scientific theories.

SCIENCE AND OBSERVATION

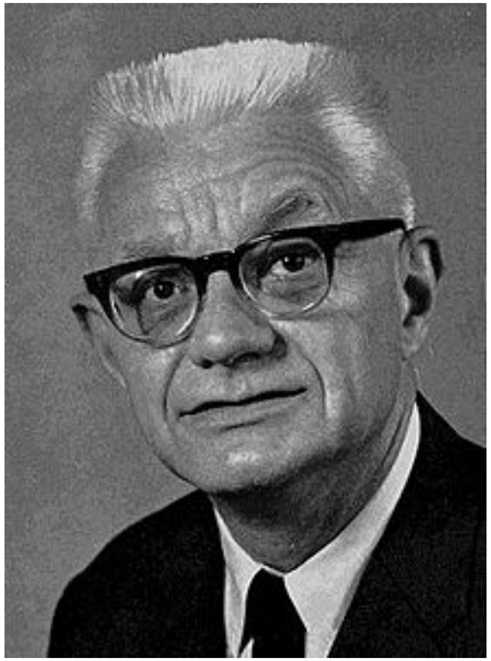
- Logical empiricism faces problems, however, one of which is the *theory-ladenness* of empirical data. Logical empiricism assumes that there is a theory-neutral way of understanding scientific observation, but in fact what observations we make may well depend upon prior theoretical knowledge.
- For example, we talk about seeing the sun rising in the morning, which reflects our pre-theoretical (manifest) conception of the sun orbiting the earth rather than vice versa. But once we know that the earth in fact orbits around the sun, although we don't strictly speaking see anything different, we are now observing the interrelationship between the sun and the earth in a different way.

EXPLANATION AND PREDICTION

- Scientists do not merely record their observations of the world around them. What they are trying to do in constructing theories on the basis of these observations is to come up with something that can *explain* what they have observed, and which can also *predict* what will happen.
- A successful scientific theory is thus one that is able to explain a lot of empirical phenomena, and which can be used to make powerful scientific predictions. In this way, we gain scientific *understanding* of the world around us.
- What constitutes a good scientific explanation?

THE DEDUCTIVE-NOMOLOGICAL MODEL

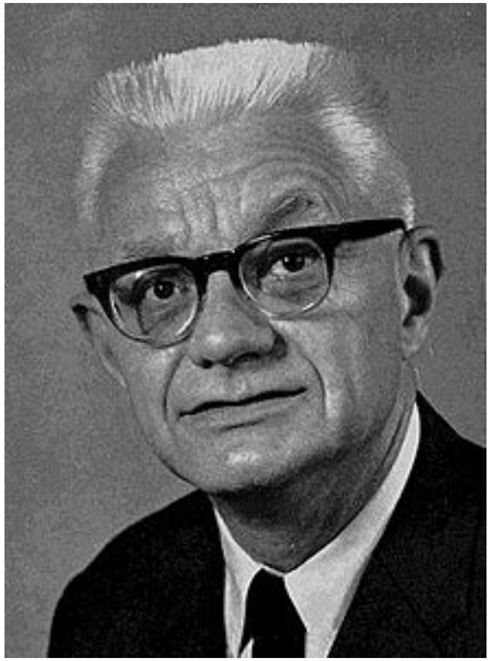
- For a long time the dominant account of scientific explanation was the *deductive-nomological model*, or covering-law model, due to Carl Gustav Hempel (1905-97).
- The nomological aspect of this model is that the premises in a scientific explanation must appeal to a law of nature. The deductive aspect of the model is that according to this view the premises should logically entail the conclusion (i.e., the conclusion can be logically deduced from the premises).
- So, for example, from the premises that (i) the child's cells have three copies of chromosome X, and (ii) any child whose cells have three copies of chromosome X has condition Y (the 'law of nature'), we can deductively infer: (iii) the child has condition Y.



Carl Gustav Hempel (1905-97)

THE DEDUCTIVE-NOMOLOGICAL MODEL

- One problem facing the deductive-nomological model of scientific explanation is that it seems to be too inclusive.
- To use an example due to Wesley Salmon, we can employ the deductive-nomological model as follows: (i) Billy (a man) takes birth control pills, (ii) no-one (almost no-one anyhow) who takes birth control pills gets pregnant ('law of nature'), hence (iii) Billy will not get pregnant.
- The reasoning fits the model, and of course the premises and the conclusion are all true, but this hardly seems a good scientific explanation of why Butch will not get pregnant!



Carl Gustav Hempel
(1905-97)

SCIENCE VERSUS PSEUDO-SCIENCE

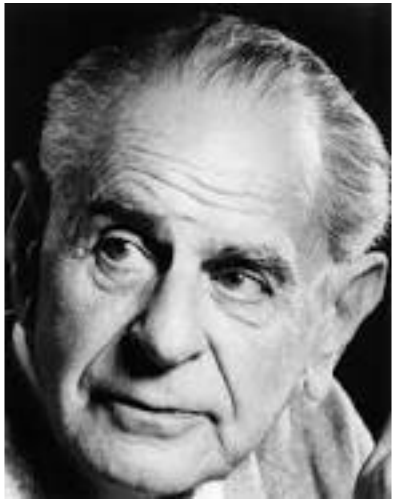
- One of the issues that faces philosophy of science is the so-called *demarcation problem*.
- This is the problem of distinguishing between genuine science and *pseudo-science* (i.e., inquiries which might superficially look like scientific inquiries but in fact are nothing of the sort).
- Think, for example, of the difference between astronomy (real science) and astrology (fake science). There clearly is an important difference here, but what marks it?

SCIENCE VERSUS PSEUDO-SCIENCE

- One way of thinking about science is that it involves making empirical observations and then, via *induction*, drawing general consequences.
- For example, one notes that all observed swans are white, and hence concludes that all swans are white. This is an inductive inference, in that although it makes the conclusion likely, it doesn't guarantee that the conclusion is true. (In fact, this conclusion is false, as there are black swans).
- Induction is in contrast to *deductive* inferences, where the premises logically entail the conclusion. That is, if the premises are true, then the conclusion must be true. (For example: All men are mortal, Socrates is a man; hence, Socrates is mortal).

FALSIFICATIONISM

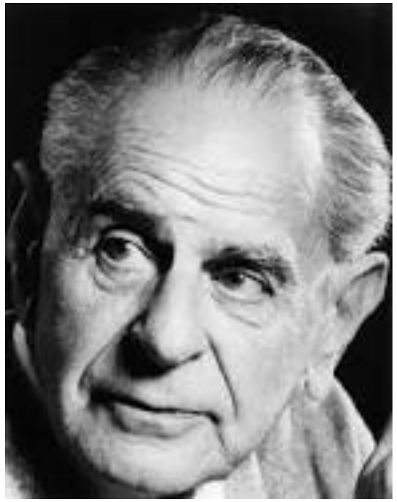
- Merely noting that the scientific method is inductive in this way doesn’t solve the demarcation problem, however, as there are lots of intuitively non-scientific inquiries that are also inductive (e.g., astrology).
- One very influential response to the demarcation problem was proposed by Sir Karl Popper (1902-94). He argued that the scientific method is not inductive at all, but rather *deductive*.
- In particular, he argued that scientists make bold conjectures on the basis of what they have observed and then seek to falsify them. His proposal is thus known as *falsificationism*.



Sir Karl Popper
(1902-94)

FALSIFICATIONISM

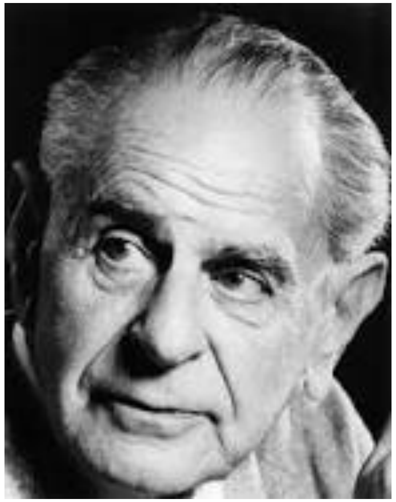
- Suppose a scientist has noted that all observed swans so far have been white. She might therefore make the bold conjecture that all swans are white. Other scientists would then seek to falsify this claim by producing a non-white swan.
- Notice, however, that if they did produce a non-white swan then they would thereby *deductively* show that the bold conjecture is false. After all, if there exists a non-white swan, then this logically entails that not all swans are white.
- So on this view the scientific method is deductive rather than inductive. Moreover, Popper claimed that this solved the demarcation problem, in that only genuine scientific theories were falsifiable. Pseudo-science, in contrast, such as astrology, was never falsifiable (since one could always get the facts to fit with the theory).



Sir Karl Popper
(1902-94)

FALSIFICATIONISM

- Falsificationism does face some problems, however.
- For one thing, it's unclear how this view accounts for *scientific progress*. After all, one might naturally think that such progress involves the accumulation of scientific knowledge, and yet on this view we never know that a scientific claim is true, only that it is false.
- But a more serious problem with falsificationism is that it is in fact very difficult to definitively falsify a scientific theory. Recall that we noted earlier that observations can be *theory-laden*. This means that in response to recalcitrant observations we always have the option of disputing the observations themselves (e.g., that thing can't really be a swan if it isn't white).



Sir Karl Popper (1902-94)

SCIENTIFIC REALISM AND INSTRUMENTALISM

- According to *scientific realism*, there is an external world out there (i.e., independent of our observation of it) that is examined via scientific inquiry, such that we are gradually coming to know more and more about the nature of that world.
- Of course, such knowledge, like all empirical knowledge in general, is *fallible*, in the sense that we might think we know something and turn out not to know it. But nonetheless, scientific realism contends that science can in principle deliver us objective knowledge of a world that is external to us.
- In contrast to scientific realism, some philosophers of science, known as *instrumentalists*, argue that science is just a way of explaining and predicting phenomena, with no claim to be approximating objective reality. On this view, in endorsing science we are not committed to holding that there is an objective reality that we are trying to model using scientific inquiry.

SCIENTIFIC REALISM AND INSTRUMENTALISM

- One advantage of scientific realism is that it can account for *scientific progress*. On this view, we are to understand such progress as the accumulation of scientific knowledge, thereby enabling us to have an increasingly accurate conception of an objective external reality.
- Indeed, if scientific realism is not true, then how do we account for our increasing scientific success (e.g., our success in predictions, our technological developments, and so on)? This is the so-called *no miracles argument*, since it seems that unless scientific realism is true then such success is a miracle.
- In contrast, if scientific inquiry is just understood instrumentally, then it is harder to account for the appearance of scientific progress. On this view, this just means that our theories are better at explaining and predicting empirical phenomena. But if they are not more accurate—i.e., if they are not getting better at approximating an objective external reality—then what makes this the case?

THE UNDERDETERMINATION THESIS

- One problem for scientific realism is the *underdetermination of theory by data*.
- This thesis states that for any set of empirical data, there will always be multiple scientific theories that are consistent with that data.
- (Alternatively, to use some terminology that we employed in an earlier segment of the course on metaphysics, we can say that these competing theories are all *empirically adequate*, in that they are all compatible with the empirical data).

THE UNDERDETERMINATION THESIS

- So, to take our example using swans, a set of observations involving mostly white swans, but one apparent black swan, can be equally explained by the following three 'swan' theories:

(i) most swans are white, but some are black;

(ii) all swans are white, but some white swans look black in certain conditions;

(iii) all swans are white, but there is also a completely distinct creature that looks just like a black swan.

- The crux of the matter is that if there are indeed multiple scientific theories consistent with the empirical data, then how do we choose between them? In particular, if this choice is arbitrary, then how can scientific realism be true?

SCIENTIFIC INCOMMENSURABILITY

- Another problem for scientific realism is posed by *scientific incommensurability*. Many historians of science–most notably Thomas Kuhn in his seminal work, *The Structure of Scientific Revolutions* (1962)—have argued that science does not in fact proceed as scientific realism would suggest.
- In particular, rather than science involving the gradual accumulation of scientific knowledge, it instead involves revolutionary paradigm-shifts whereby one scientific paradigm is replaced by a completely new paradigm.
- Such revolutions occur when the anomalies faced by the prevailing theory become overwhelming (otherwise, the prevailing theory is simply 'adjusted' to deal with the problematic data).

Thomas Kuhn (1922-96)

SCIENTIFIC INCOMMENSURABILITY

- Crucially, these paradigms are *incommensurable*, which means that there is no common measure between the two.
- If that's right, then a scientific revolution (e.g., as occurred in theoretical physics as regards Einsteinian relativity) did not result in an accumulation of scientific knowledge (i.e., new scientific knowledge adding to the old scientific knowledge).
- Instead, the new paradigm creates a whole new body of scientific knowledge that is incommensurable with the previous body of claims that we previously thought amounted to knowledge.

Thomas Kuhn (1922-96)

SCIENTIFIC RESEARCH PROGRAMMES

- A different account of scientific progress is offered by the Hungarian philosopher, Imre Lakatos (1922-74).
- He argues that rather than scientists operating within all-encompassing paradigms, we should instead think of scientific theories as being part of a wider *research programme*.
- This will include a 'hard' theoretical core containing theoretical claims that are central to the research programme. This core is protected from falsification by a 'protective belt' of auxiliary hypotheses, which are adapted to deal with recalcitrant data (i.e., which conflicts with the claims in the theoretical core).

Imre Lakatos
(1922-74)

SCIENTIFIC RESEARCH PROGRAMMES

- The idea is that this protective belt enables the research programme to be properly developed, and not simply abandoned at the first sign of counterevidence.
- Crucially, however, one cannot protect the theoretical core from counterevidence indefinitely. Lakatos here distinguishes between *progressive* and *degenerating* research programmes.
- The former makes novel predictions that are subsequently empirically confirmed, and integrates itself with other established scientific claims.
- The latter, in contrast, simply involves defensively, and in an *ad hoc* way, introducing auxiliary hypotheses to evade counterevidence. Eventually, degenerating research programmes are abandoned.

Imre Lakatos
(1922-74)