## Notes and References

1 THOMAS SOWELL (1980) *Knowledge and Decisions*, p. 97. New York, Basic Books.
2 HARRIET BEECHER STOWE (n.d.) *Uncle Tom's Cabin*, p. 206. New York, Books Inc.
3 ST THOMAS AQUINAS *Summa Theologica*, Part I, Question 2.
4 These principles appear—as Axioms III and IV, respectively—in a very characteristic exercise included in Descartes' replies to the second set of solicited Objections to his *Meditations on First Philosophy*: "Reasons which prove the existence of God and the distinction between the mind and the human body, arranged as geometry".
WILLIAM PALEY (1836) *Natural Theology*, 2 Vols. London, Charles Knight.

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# A scientist looks at philosophy

**LEN FISHER**

A discussion of the different roles of models in scientific and philosophical thinking

We are all in the business of trying to make sense of the world in which we live. Scientists and philosophers make their living doing this. Scientists are seen by many people as dealing with facts, logically organized ('explained') by hypotheses which can be tested and proved. Philosophers are seen as dealing with ideas, and focusing on problems which are too hard to be solved by scientists but too important to be left alone. To many scientists, philosophy is a useless endeavour. To many philosophers, scientists are rude mechanicals.

As a practising scientist now studying philosophy, I have a problem with this popular dichotomy. Science certainly always deals with observables, while philosophy only sometimes does[1]. Scientific theories, though, are restricted to postulating relations between observables, and a theory is not considered scientific unless that relationship can be tested.

Nevertheless, while philosophical theories can sometimes be proved (for example, some theories in the field of logic), scientific theories never can. They must always be based on at least one belief, either that the laws of nature in the future will continue to be the same as they were in the past, or that they will change in some predictable way. The first belief (the uniformity of nature) is one that we use not only in science but in our everyday lives, and the logic that we use in following this assumption is called induction. But there is no logical proof of induction, for a reason which was first brought to our attention by David Hume.

Hume pointed out that there can never be a *necessary* connection between distinct events—for example, between the directions of movement of two colliding snooker balls and their subsequent behaviour. Our predictions are based on past experience alone, which may be a trustworthy guide but is never a provable one. For example (recasting an example of Nelson Goodman's), let us assume that some emeralds are green, and some are grue. 'Grue' is the property of being green until midnight at the end of the century, and blue thereafter. We have no way of distinguishing between the two types of emerald.

We can of course *disprove* theoretical relationships if the predicted behaviour does not eventuate. Karl Popper argued that the difference between scientific and non-scientific theories is just that scientific theories are susceptible to such disproof.

But is this really true? Sufficiently accurate measurements will usually reveal some small difference between theory and experiment. Scientists in fact live for such moments. On Popper's criterion, we should discard our theory when this happens. But of course we



don't. We first look for complicating factors which may explain the difference.

This brings me to my main point. In any theory, scientific or philosophical, we cannot possibly take account of everything in the universe. We must always abstract some observables or ideas, and assume that nothing else is significant so far as our theory is concerned. That is, we inevitably use *models*.

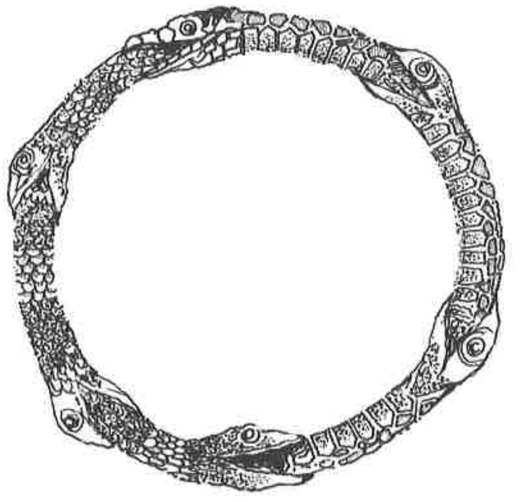
In our snooker ball example, we always have to idealize the situation in some way. We might assume (guess) that the balls are elastic spheres, which store all of their energy of deformation when they hit and give it all up on recoil. When theory and experiment fail to agree, we discard this model. Perhaps we measure the shapes of the balls more closely, and find that they are not quite spherical. Or we may try the assumptions that they are not perfectly elastic (plasticine balls would be expected to behave very differently), or that their surfaces are slightly rough.

This is not to say that scientists do not test and discard their theories from time to time, but mostly it is the models that go. To my mind this is the central difference between scientific and philosophical theories; *in philosophy our personal model of the universe is central to, and indivisible from, any theory that we develop. In science, models can be disposable props.*

The generalization with regard to philosophical theories cannot be proved; all I can say is that all of the theories to which I have so far been introduced, for example, in the fields of ethics and the theory of knowledge, seem to be of this type. Indeed, it is hard to see that it could be otherwise[2]. With regard to science, though, my assertion has a basis both in logic and in practice.

The logical basis for my assertion goes back to Hume. If there is no *necessary* relation between distinct events, then we can construct an infinite number of models to link any two events. Our belief in the models may increase as we find them to be applicable to more and more situations, but this does not mean that they are right, or that we can ever prove them to be right.

In practice, the models used by both scientists and philosophers are inevitably based on experience[3]. Scientists, though, are able to use models in an eclectic manner not generally available to philosophers. Scientists' models are used to predict relationships between observables. The relationship is the thing that matters, not the model, which may itself be no more than an analogy. For example, a very successful model of the stability of atomic nuclei was drawn from an analogy with the stability of a falling drop of water as it progressively increases in size. The model was used to derive a relationship between nuclear size and stability. The relationship successfully predicted other aspects of atomic behaviour, but this does not mean that atomic nuclei are drops of water!

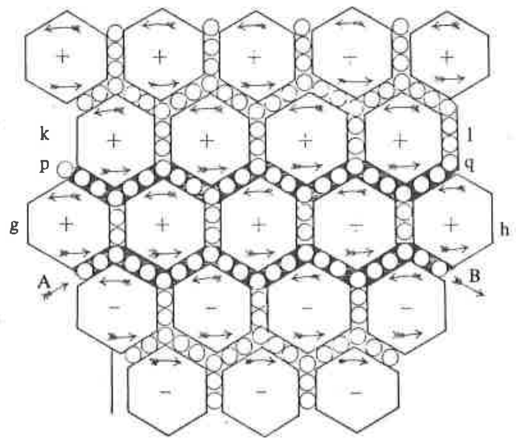


*Kekulé's snakes—clearly a dispensable model.*

Kekulé dreamed that the benzene molecule was a ring of interlinked snakes. The resulting theory was right, but the model is obviously disposable.

Many philosophers will not have heard of Maxwell or his equations, any more than many scientists will have heard of Gettier or Rawls. Yet Maxwell's four simple equations underpin physics. They describe *everything* about electric and magnetic behaviour—light, X-rays, the earth's magnetic field, radiant heat, etc. They even describe relativistic effects, although they were written down forty years before relativity was conceived. They have passed every test so far.

The model that Maxwell used was of vortices—little electrical tornados in the ether which he guessed must permeate space. We now know that there is no ether, and hence no vortices in it. Nevertheless, Maxwell's equations, which are descriptions of relationships between observables, remain valid. The model was disposable.




*Maxwell's vortices—also a dispensable model?*

The human mind being what it is, physicists have replaced Maxwell's model with another one, in which they visualize electric and magnetic effects being transmitted over a distance by means of waves. Indeed, this model works, in that it leads to Maxwell's equations, but this does not mean the model is right. Waves in what?

Some scientists do not use models as mental props, but instead make direct guesses at the relationship between observables. This is a matter of personal choice, and is more of a continental trait than a British trait. A famous case is that of the Austrian Erwin Schrödinger, who guessed that the behaviour of small particles might be describable by a relationship similar to that used for waves. The study of the resulting equation, which underpins quantum mechanics, has led many a physicist to give up physics in favour of philosophy.

Some of the behaviour which is well described by Schrödinger's equation is simply absurd if judged by models based on direct experience. Consider the behaviour of light, for example. If we shine a sufficiently weak source of light at a phosphorescent screen, we see individual flashes on the screen, as if 'particles' (photons) of light were hitting it. If we interpose a second screen, with a slit in it, the flashes are reduced to a single line 4 where the 'particles' pass through the slit. If we replace the slit with two closely spaced slits, we still see individual flashes, but if we record their positions they don't just form two lines, but a more complex pattern, identical to that which we would expect if the light were behaving as a wave. So what is light; waves or particles? Or both?

From the point of view that I am espousing here, the question is misconceived. Particles and waves happen to be the only two ways of producing an effect at a distance that we can imagine from direct experience—hence, they form the basis of all the models that we use in thinking about such effects. We can imagine sending material from one place to another, or creating a disturbance in a medium between the two places. Bullets, or light viewed as particles, are examples of the first model. Waves are an example of the second model. It seems impossible to conceive of them simultaneously. What are we to do in such cases, when *none* of our models based on experience work?

The answer is to grasp the opportunity with both hands. We can do this in three ways. The first is to invent a new concept. Entropy, energy, atoms and molecules are all concepts that have been invented, although long familiarity sometimes leads us to believe that they are derived from experience. Curved space is another concept which has been invented (and which is now used to explain relations in the large scale geometry of the universe which are inexplicable in terms of Euclidean geometry). As pointed out above, some of the properties of curved space require us to consider carefully what we mean in asking such questions as 'Is there anything beyond the universe?'.

A less familiar example of an invented concept is the 'H' of Boltzmann's H-theorem, a fundamental theorem of statistical thermodynamics. A related concept, that of entropy, is roughly describable as 'degree of randomness', but there is no such experiential lnk for 'H'. Sufficient to say that the H-theorem predicts that, given sufficient time, the organization of any closed system will return arbitrarily close to that which it had at some earlier time. Is the universe a closed system? If so, the H-theorem may have a strong bearing on the question of reincarnation (I am indebted to my wife, Wendy Laughlin, for pointing out this very interesting potential relationship between science and philosophy).

The second is to modify an existing concept. Time provides two wonderful examples here. Current theories of the origin of the universe produce equations (relations between observables) in which time has a definite starting point. Even more counter-intuitive (i.e. counter-experience), positrons can be described as electrons going backwards briefly in time. Both examples require a modification of our concept of time.



A third approach is to accept a relationship between observables without looking for a concept with which to model it in terms of experience. This is true philosophical acceptance of our limitations. As Richard Feynman, Nobel Laureate, put it, all that we can reach is the rules of the game. We cannot penetrate to any underlying reality, if such there be. Yet just considering the rules themselves provides plenty of grist for the philosophical mill. Witness, for example, the thriving debate on whether quantum mechanical indeterminancy, a practical discovery of science, allows us to resolve the question of free will vs determinism.

In all of the three approaches given above, science has provided us with a splendid opportunity to extend the range of concepts upon which philosophy is necessarily based beyond those which we can derive from our immediate experience. Philosophy, in its turn, keeps our minds firmly focused on the major problems, without regard for their solvability by any approach, scientific or otherwise. Both science and philosophy are cultural activities which could and should exist in a symbiotic relationship. I look forward to the time when popular prejudice and our education system can be overcome to allow them to do so.

## Notes

1 It is a matter for the theory of knowledge whether observables correspond to 'facts'.

2 Although Wittgenstein made the controversial claim that his ideas were only props to be discarded after the reader had understood them. Andrew Pyle has also pointed out that the argument of the mediaeval nominalists (that God can do anything that doesn't involve a contradiction, but alternative 'natural' laws are perfectly conceivable) might be construed to mean that our presently believed laws of nature are disposable. This latter example, though, does not to my mind mean that we are *using* currently understood laws as disposable props.

3 The subject of whether there can be *a priori* knowledge is a vexed one, aired by Kant. One of Kant's examples is that we were born with the knowledge that the universe is a space of three Euclidean dimensions. This is unfortunate, if correct, because the geometry of the universe is not Euclidean, but curved. In one such geometry, the curves close in on themselves, making the question 'What is outside the universe?' meaningless.

4 Strictly speaking, the line is slightly fuzzy. It is perhaps also worth adding here that, while the philosophy of quantum mechanics is now a major activity with many detailed arguments, I am not personally qualified in this field, and have simply chosen a few examples from it for the purposes of this essay.

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# Before and after Babel

**ADAM CZERNIAWSKI**

On the dream—or nightmare?—of a universal language

## (1) Language-barriers

Why are humans divided by language barriers? What would the world be like if we all spoke the same language?

When God created Adam, He gave him speech and invited him to name the objects that make up the world. What was that language? It had to be one in which He could make Himself understood. Given that Adam and Eve were created in His image, that should have been easy. Yet there must have been misunderstandings between them from the start, for words in the mouth of an eternal