Representing and Intervening:
Introductory topics in the philosophy of natural science

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Philosophy of Science

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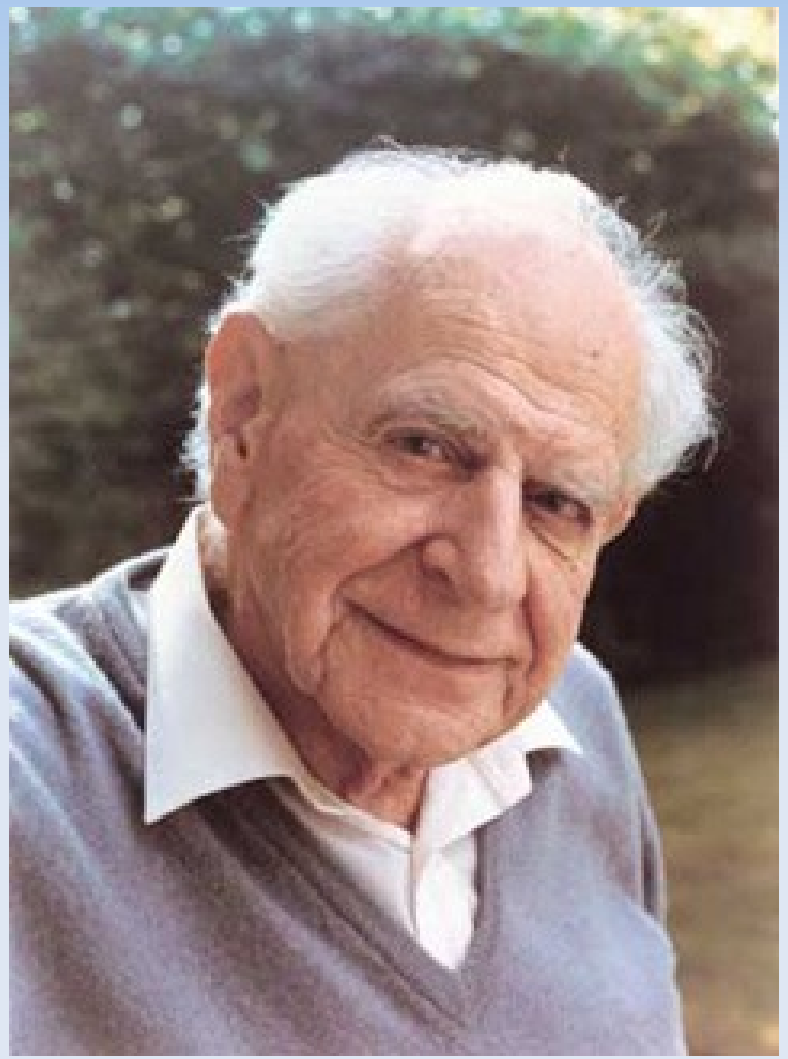
Abstract

The philosophical issues discussed:-

- What is truth?
- What is reality?
- Are the entities postulated by theoretical physics real, or only constructs of human mind for organizing our experiences.
- The author concludes that we shall count as real what we can use to intervene in the world to affect something else, or what the world can use to affect us.

Rationality



Karl Popper (1930's)

Falsification

- Study of meanings is irrelevant.
- It is not bad to be pre-scientifically metaphysical.
- Verification was wrongheaded.
- A proposition is scientific if it is 'falsifiable'.
- Falsification is from the top down
- There is only one logic that is deductive logic.
- Rationality is a matter of method of conjecture and refutation.

Falsificationism

Emphasizes the testing and falsifying of conjectures rather than verifying or confirming them. A theory inconsistent with an observation must be rejected.

But this did not bring pleasingly honest and objective science, because

a. it became very common to propose a theory even when it was not in lieu with all the known facts,
b. there is no firm theory-observation distinction.
c. Pierre Duhem made a claim that “the theories are tested via auxiliary hypotheses”

Rationality

Rudolf Carnap (1930's)

Verification

- Study of meanings.
- Scientific discourse is meaningful; metaphysical talk is not.
- Meaningful propositions must be verifiable in principle.
- Verification: from the bottom up
- Observations as the foundations for our knowledge.
- Theory of confirmation.

Crisis of rationality

Thomas Kuhn (1962)

'Crisis of rationality' arose after publishing of Thomas Kuhn's book- *The Structure of Scientific Revolutions (1962).*
"**History, if viewed as a repository for more than anecdote or chronology, could produce a decisive transformation in the image of science by which we are possessed"**.

Kuhn's Structure of Scientific Revolutions

- Normal science
- Anomalies
- Modifications
- Crisis
- Revolution
- New normal science

Kuhn's attack on Rationality of Science

- Disciplinary matrix
- Paradigms
- Paradigm shifts
- Different worlds
- Incommensurability
- Objectivity

Incommensurability

- Successive and competing theories within the same domain 'speak different languages'. They cannot strictly compare to each other nor translate into each other. The languages of different theories are the linguistic counterparts of the different world we may inhabit.

- There have been numerous theories about electrons: R.A.Millikan, H.A.Lorentz, and Niels Bohr, and all had different ideas. The incommensurabilist says that they mean something different, in each case, by the word 'electron'. They were talking about different things. **This opposes scientific realism.**

Realism

- Scientific realism says that the entities, states and processes described by correct theories really do exist. Protons, photons, fields of force, and black holes are real. Theories about the structure of molecules that carry genetic code are either true of false, and a genuinely correct theory would be a true one.

- Even when our sciences have not yet got things right, the realist holds that we often get close to the truth.

... Realism

- Mesons and Muons are just as much as monkeys and meat-balls.
- We know some truths about each kind of thing and can find out more.
- There are objects really out there, and we infer their existence and their properties from our sense experience.

Anti-realism

- We construct theories about tiny states, processes and entities only in order to predict and produce events that interest us.
- Theories are adequate, or useful or applicable, but no matter how much we admire the speculative and technological triumphs of natural science, we should not regard even its most telling theories as true.
- Theories are intellectual tools which cannot be understood as literal statements of how the world is.

Anti-realism

- “Monkeys and meat-balls may be known, but talk about muons is at most an intellectual construct for prediction and control”.
- Anti-realists about muons are realists about monkeys.
- The idealist Berkeley says, “matter itself does not exists; all that exists is mental”.

Realism about Theories

- It says that the scientific theories are either true or false independent of what we know: science at least aims at the truth, and truth is how the world is.

- **Anti-realism** says that theories may be at best warranted, adequate, good to work on, acceptable, but incredible.

Realism about Entities

- It says that a good many theoretical entities really do exist.
- **Anti-realism** denies that, and says that they are fictions, logical constructions, or parts of an intellectual instrument for reasoning about the world.

Empirical Realism

Kant's Empirical realism- “Space and time are preconditions for the perception of something as an object. It is not experimental fact that objects exist in space and time although we may experimentally determine the spatio-temporal relationships of objects within the frame-work of space and time. Empirical realism grants 'the objective validity' of space in respect of whatever can be presented to us outwardly as object”.

Transcendental Realism

Immanuel Kant (1724- 1804)

Kant's Transcendental realism- "Space is nothing at all... once we withdraw.. its limitations to possible experience and so look upon it as something that underlies things in themselves. Our knowledge is of phenomena, and our objects lie in a phenomenal world. There are also noumena, things in themselves, but we can have no knowledge of these. Our concepts and theories do not even apply to things in themselves".

Things in Themselves

J.-M.Ampere (1775-1836) says-

“Theoretical entities are Kant's things-in-themselves. He insisted that we can postulate noumena and laws between them, to be tested in experience. This postulation and hypothetico-deductive method, is an intelligent investigation of the noumenal world”.

Materialism

J.J.C.Smart- (*1963),* says

"lines of forces, unlike electrons, are theoretical fictions. One can say, that this table is composed of electrons just as a wall is composed of bricks, a swarm of bees is made of bees, but nothing is made up of lines of force. There is definite number of lines of magnetic force in a given volume; only a convention allows us to count them". Smart infers that "anti-realists are wrong. There are at least some real theoretical entities like atoms, molecules and electrons. The word real marks a significant distinction, like the lines of magnetic force are not real".

Causalism

Nancy Cartwright

Nancy Cartwright advocates causalism as, “we must understand why a certain type of event regularly produces an effect. Positrons and electrons are real since we can spray them, separately on the niobium ball and thereby change its charge. It is well understood why this effect follows the spraying. Electrons are real, because we know that they have quite specific causal powers”.

Positivism

- An emphasis upon verification, or falsification
- Pro-observation
- Anti-cause
- Down-playing explanations
- Anti-theoretical entities
- Against metaphysics
- Emphasis on logic, meaning, and the analysis of language.

Positivism as Anti-cause

David Hume (1711-1776)

Hume- Cause is only constant conjugation. To say that A caused B is not to say that A, from some power or character within itself, brought B. It is only to say that things of type A are regularly followed by things of type B.

Pragmatism

Charles Sanders Pierce (1838-1914)

Charles Sanders Peirce (1839-1914) states, “the very origin of the conception of reality shows that this conception essentially involves the notion of a community, without definite limits, and capable of a definite increase of knowledge... The truths are the stable conclusions reached by that unending community of inquirers. Truth was roughly, whatever hypothesizing, inducing, and testing settled down upon”.

Growth of Science

Imre Lakatos (1922-1974)

Lakatos characterizes the growth of science as- “The unit of growth is the research program defined by hard core heuristic, and that the research programs are progressive or degenerative. The knowledge grows by the triumph of progressive programs over the degenerative ones”.

Reality and Representations

Ian Hacking-

“If reality were just an attribute of representation, and there were no alternative styles of representation, then realism would not be a problem. The problem arises only because of alternative systems of representation. This has also been suggested by Kuhn, that from revolution to revolution we come to inhabit different worlds. New theories are new representations. They represent in different ways and so there are new kinds of reality”.

Interventions

Francis Bacon (1560-1626)

Francis Bacon (1560-1626)- "Certain types of experimental findings serve as benchmarks, permanent facts about phenomena which any future theory must accommodate, and which, in conjugation with comparable theoretical benchmarks, pretty permanently force us in one direction."

For example, Michelson-Morley experiment.

Theory, Experiment, Invention

Ian Hacking-

“Some profound experimental work is generated entirely by theory. Some great theories spring from pre-theoretical experiment. Some theories languish for lack of mesh with the real world, while some experimental phenomena sit idle for lack of theory...The very word 'thermodynamics' recalls that this science arose from a profound analysis of a notable sequence of inventions. This development involved endless experiments which were imaginative trials required for the perfection of the technology that lies at the center of the industrial revolution”.

Method of Science

Induction

Humphry Davy (1778-1829)-

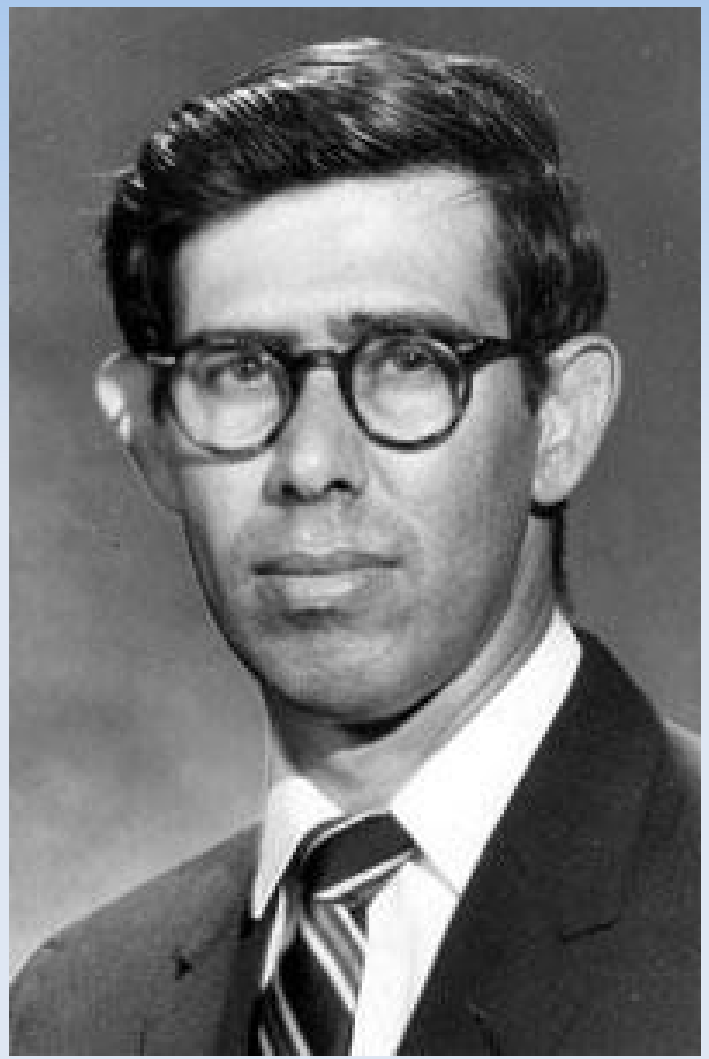
“The foundations of chemical philosophy, are observation, experiment, and analogy. By observation, facts are distinctly and minutely impressed on the mind. By analogy, similar facts are connected. By experiment, new facts are discovered; and, in the progression of knowledge, observation, guided by analogy, leads to experiment, and analogy confirmed by experiment, becomes scientific truth”.

Method of Science

Deduction

“In science all investigation is deductive or a priori. Experiment is only an aid to thought, like a calculation: the thought must always and necessarily precede it if it is to have any meaning. An empirical mode of research, in the usual sense of the term, does not exist. An experiment not preceded by theory, ie. by an idea, bears the same relation to scientific research as a child's rattle does to music”. - Justus Von Liebig (1803-73)

Observation



Dudley Shapere

Dudley Shapere, says, “Whether or not something is directly observed depends upon the current state of knowledge. Our theories of working receptors, or of transmission of information all assume massive amounts of theory. So we might think that as theory becomes for granted, we extend the realm of what we call observation”.

Why do we believe on Microscopy?

Ian Hacking-

“We believe the pictures we construct using a microscope. We can test the pictures obtained by microscopy by seeing the same bodies with grids, using quite different physical techniques, eg, a low resolution electron microscope and fluorescence microscopy. If one can see same fundamental features of structure using several different physical systems, one has excellent reason for saying, 'that's real', rather than, 'that's an artifact”.

When to consider Something as Real?

Ian Hacking-

“To alter the charge on the niobium ball, positrons are sprayed to increase the charge and electrons to decrease it**, if you can spray them, then they are real. What convinces me of realism is that by now there are standard emitters with which we can spray positrons and electrons in a precise manner. We understand the effects, we understand the causes, and we use these to find out something else”.**

Experimentation and Scientific Realism

Ian Hacking

“Experimental work provides the strongest evidence for scientific realism... This is because entities that in principle cannot be observed are regularly manipulated to produce a new phenomena and to investigate other aspects of nature”.

Changing Times

Alaxender Bain, 1870, states-

"Some hypothesis consist of assumptions as to the minute structure and operation of bodies. From the nature of the case these assumptions can never be proved by direct means. Their merit is suitability to express phenomena. They are representative fictions. All assertions as to ultimate structure of the particles of matter are and ever must be hypothetical".

Changing Realities

Ian Hacking (1995)-

"A century ago the statement of Bain was correct. At that period of time any proof for their existence would have been the representation of representation. But in spite of all such statements, today the scientists in general have become realists about atoms and electrons. Our ability to manipulate electron by using their well-understood properties is now considered as proofs of their existence. We can now put a spin on electrons, polarize them and get them thereby to scatter in slightly different proportions."

CONCLUSION

The arguments for Realism of postulated or inferred entities, can never be settled through theories: which are mere representations. The real truth of science can only be established through the endeavor of intervening upon this world by manipulation and experimentation of such entities; by gaining and utilizing the in-depth knowledge of their causal powers and effects.

According to Ian Hacking- "**The final arbitrator in philosophy is not how we think but how we do".**

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Thanks to all !!!