

Are scientific theories true?

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1. Introduction

Two possible aims for science:

- i. The aim of science is to “save the phenomena” (scientific anti-realism)

OR

- ii. The aim of science is to tell us a true story about nature (scientific realism)

2. Ancient Greek astronomy and Duhem on “saving the phenomena”



3. From Copernicus to Galileo

- Copernicus' dedicatory letter to Pope Paul III:

“I began myself to consider the movement of the Earth. It seemed an absurd notion. Yet I knew that my predecessors had been granted the liberty to imagine all sorts of fictive circles to save the celestial phenomena. I therefore thought that I would be similarly granted the right to experiment, to try out whether, by assigning a certain movement to the earth, I might be able to find more solid demonstrations of the revolutions of the celestial spheres than those left by my predecessors”.

[from P. Duhem, *To Save the Phenomena*, English ed. 1969, University of Chicago Press, p. 63]

- Osiander's Preface to Copernicus' *De revolutionibus*:

“For the astronomer's job consists of the following: to gather together the history of the celestial movements by means of painstakingly and skillfully made observations... and then to think up or construct whatever hypotheses he pleases such that on their assumption, the self-same movements, past and future both, can be calculated by means of the principles of geometry.... It is not necessary that these hypotheses be true. They need not even be likely. This one thing suffices that the calculation to which they lead agree with the result of observation”.

[from P. Duhem, *To Save the Phenomena*, English ed. 1969, University of Chicago Press, p. 66]

- Galileo and the telescope:

- i. Mountains on the Moon

- ii. Jupiter's satellites

- iii. Phases of Venus

Galileo embraced Copernicanism as a physical *truth*.

4. Scientific realism

Scientific realism is the view that scientific theories, once **literally construed**, aim to give us a **true story** of the way the world is.

Semantic aspect of the above def.

Epistemic aspect of the above def.

Semantic aspect of the above def.

We should take the **language of science** at face value. This means the following:

- We should take **theoretical terms** (e.g. terms of a scientific theory, say “electron”, “negative charge”, ...) as **referring to**, or **picking out** real entities or properties in the world (“electron” refers to the electron)
- We should also take the **sentences** of our scientific theories (e.g. “electrons have negative electric charge”) as **corresponding to** real states of affairs in the world (electrons *really* do have negative electric charges)

Epistemic aspect of the above def.

Acceptance of a scientific theory implies the **belief** that the theory is **true**.

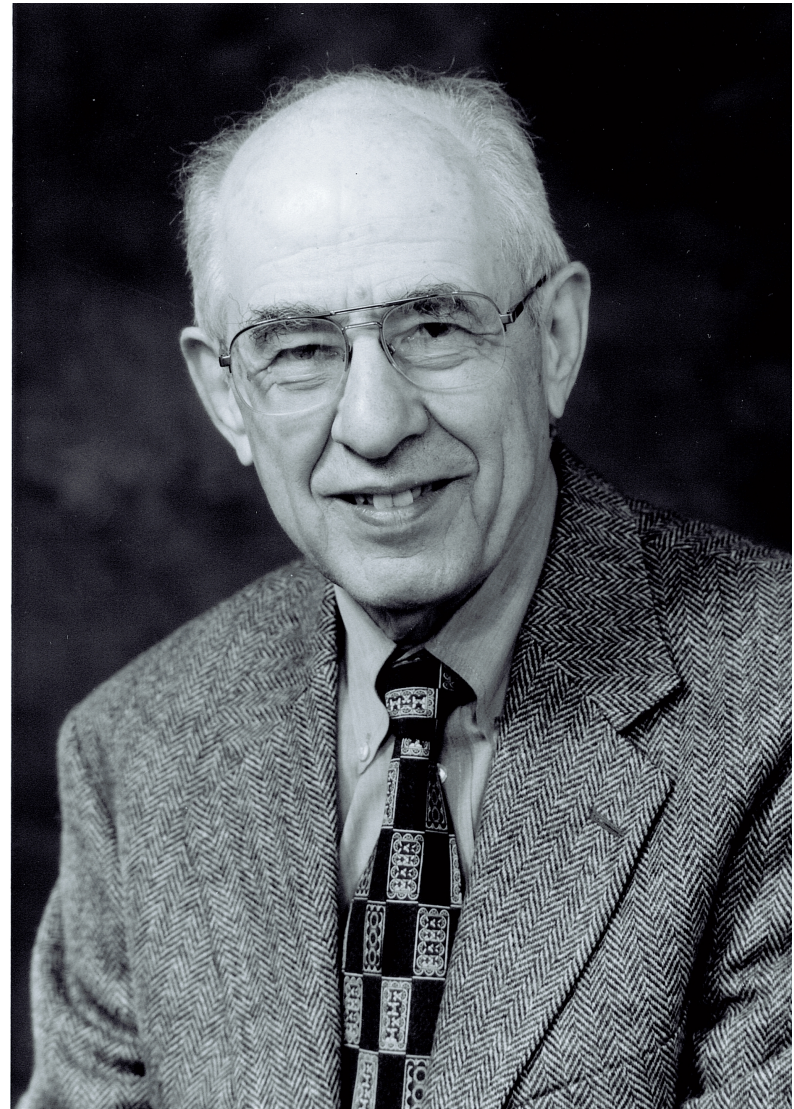
E.g.: accepting the electron theory implies **believing** that the electron theory is **true**.

Namely, we **believe** that the theoretical terms (“electrons” and “negative charges”) **refer to** real entities and properties in the world, and we also **believe** that what the theory says about electrons and negative charges **correspond to** real states of affairs in the world.

- The No-Miracles Argument (NMA) for scientific realism

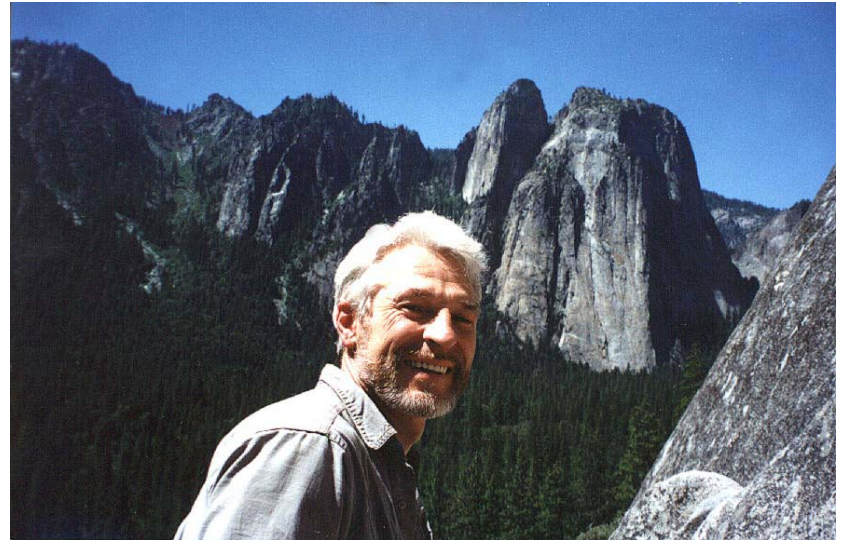
(Hilary Putnam, 1975, p. 73):

“the positive argument for realism is that it is the only philosophy that does not make the success of science a miracle”



5. Scientific antirealism

- Bas van Fraassen's "constructive empiricism" (*The Scientific Image*, 1980, Clarendon Press).
- Agree with the **semantic aspect** in the def. of realism
- But disagree with the **epistemic aspect**: scientific theories need not be **true** to be good.



Observable vs. unobservable distinction:

- *Observable* phenomena are all past, present, and future phenomena that a theory can save (not just the actual *observed* phenomena!). They are observable because they are *observable-to-us*, i.e., they can be observed **with our naked eyes**.
- *Unobservable* entities, on the other hand, are those that cannot be in principle observed with our naked eyes.

Examples

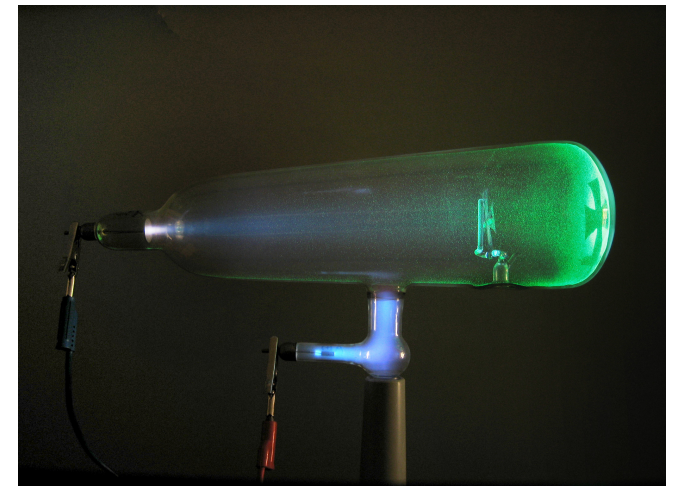
- ***Observable phenomena***: zebras, elm trees, fossils, but also Moons of Jupiter (astronauts could take a spaceship and have a close look at them) and so on...
- ***Unobservable phenomena***: bacteria, viruses, DNA strands, electrons, protons, quarks, and so on... (do what we may, we can never achieve an unaided vision of any of these entities with our naked eyes).

- Science aims to give us theories which are **empirically adequate**; and acceptance of a theory involves as a *belief* only that the theory is **empirically adequate**.
- A theory is *empirically adequate* if what it says about the **observable** things and events in the world is **true** – i.e., if it *saves the phenomena*.

Truth vs. empirical adequacy

If a scientific theory is **true** (in the scientific realist sense), then it is also **empirically adequate** (in van Fraassen's sense).

E.g.: if the electron theory is **true** (as defined above, i.e. there really are electrons, and they do have negative charges...), then it is also **empirically adequate** (e.g., it can save the **observable phenomena** about electrons, say the greenish fluorescence we observe in cathode rays)



- But not the other way around: **empirical adequacy** does not imply the scientific realist's notion of **truth**.
- For van Fraassen, the electron theory is **empirically adequate** with respect to the **observable phenomenon** of the greenish fluorescence in cathode rays (among others), without being necessarily **true** (without us having to **believe** that there really are **unobservable** entities called “electrons”, having really negative charges, and so forth).

- Van Fraassen's Darwinian response to the No-Miracles argument:

Theories are **naturally selected** in such a way that those with false observational consequences are discarded, and the survival-adaptive ones are those that “fit the observable phenomena or, in other words, **save the phenomena**.”

The success of science is not miraculous and can be explained in terms of **empirical adequacy**, not in terms of **truth** with respect to ***unobservable entities!***

6. Inference to the Best Explanation: realism vindicated?

Two realist rejoinders against van Fraassen's constructive empiricism:

- I. van Fraassen's Darwinian response to the No-Miracles argument does not cut any ice.

One thing is to explain why only successful theories survive; another thing is to explain why a theory is successful in the first instance. Only realism can explain the latter.

II. Why suspend belief about unobservable entities (be they atoms, electrons, or DNA)?

Philip Kitcher's and Peter Lipton's reply:

the inferential path that leads to *unobservable entities* is one and the same with the inferential path that leads to *unobserved observables* (e.g. extinct species like trilobites and dinosaurs), namely

Inference to the Best Explanation

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We infer the hypothesis, which, if *true*, would provide the *best explanation* for the available evidence.

7. Conclusion

To sum up, two main views about the aims of science:

Scientific realism sees **truth** as the main aim of science.

Constructive empiricism sees **empirical adequacy** as the main aim of science.