

Einstein on Epistemology

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Abstract

Surely, philosophical enquiries are no longer helpful for the theoretical physicist, right? Well, don't be too quick to think so. Warning: this essay contains academic philosophical language that may offend some readers.

1 Introduction

Did Einstein really think that philosophy is important to scientists and to scientific knowledge? Yes! And I will attempt to prove this thesis in this article, but only about epistemology. Read Einstein's articles and essays and you can't help but see that he was very well read of the philosophers of importance up to his own time, going back at least to Galileo.

By the way, the following quotes are intended only to represent Einstein's personal epistemology of science and not epistemology generally.

//// Warning!!! Beginning of physics with philosophy ////

2 The Evidence

Within five weeks the special theory of relativity was completed. I did not doubt that the new theory was reasonable from a philosophical point of view. I also found that the new theory was in agreement with Mach's argument.

— Found in: “How I created the theory of relativity,” translation of a lecture Einstein gave in Japan in 1922, translated by Yoshimasa A. Ono, *Physics Today*, Aug. 1982, p. 45.

And,

I believe that with this result the general theory of relativity can be satisfactorily understood epistemologically.

— Found in: “How I created the theory of relativity,” translation of a lecture Einstein gave in Japan in 1922, translated by Yoshimasa A. Ono, *Physics Today*, Aug. 1982, p. 47.

And,

In classical mechanics, and no less in the special theory of relativity, there is an inherent epistemological defect which was, perhaps for the first time, clearly pointed out by Ernst Mach.....No answer can be admitted as epistemologically satisfactory, unless the reason given is an observable fact of experience.

— Found in: *The foundation of the general theory of relativity*, A. Einstein, Dover Books, 1916, reprinted, pp. 112–113.

And,

Yet every theory is speculative. When the basic concepts of a theory are comparatively “close to experience” (e.g., the concepts of force, pressure, and mass), its speculative character is not so easily discernible. If, however, a theory is such as to require the application of complicated logical processes in order to reach conclusions from the premises that can be confronted with observation, everybody becomes conscious of the speculative nature of the theory.¹ In such a case an almost irresistible feeling of aversion arises in people who are inexperienced in epistemological analysis and who are unaware of the precarious nature of theoretical thinking in those fields with which they are familiar.

— Found in: “On the Generalized Theory of Gravitation,” A. Einstein, *Ideas and Opinions*, Three Rivers Press, p. 349.

Einstein is clearly saying that one reason people have trouble with relativity is that they are not trained in thinking epistemologically. How sad. Anyway,

If we consider that part of the theory of relativity which may nowadays in a sense be regarded as bona fide scientific knowledge, we note two aspects which have a major bearing on this theory. The whole development of the theory turns on the question of whether there are physically preferred states of motion in Nature (physical relativity problem). Also, concepts and distinctions are admissible to the extent that observable facts can be assigned to them without ambiguity (stipulation that concepts and distinctions should have meaning). This postulate, pertaining to epistemology, proves to be of fundamental importance.

— Found in: “Fundamental Ideas and Problems of the Theory of Relativity,” A. Einstein, *Albert Einstein’s Theory of General Relativity*, G. Tauber, Crown Press, p. 51.

Wow! Imagine that! An epistemology principle proves to be of fundamental importance to Einstein. (It clearly has no physical content so where does it fit into his theory of relativity?) Moving on:

¹One would hope, at least.

The special relativity theory resulted in appreciable advances. It reconciled mechanics and electrodynamics. It reduced the number of logically independent hypotheses regarding the latter. It enforced the need for a clarification of the fundamental concepts in epistemological terms.

— Found in: “Fundamental Ideas and Problems of the Theory of Relativity,” A. Einstein, *Albert Einstein’s Theory of General Relativity*, G. Tauber, Crown Press, p. 54.

As I showed above in a quote from Einstein’s GR paper, he took this epistemological viewpoint right on to the general theory of relativity:

epistemology → heuristics → a testable theory

Einstein’s explicit epistemological approach made for constraints on his relativity research program that helped to give it a clear focus.

The axioms define the objects of which geometry treats. Schlick in his book on epistemology has therefore characterized axioms very aptly as “implicit definitions.”

— Found in: *Geometry and Experience*, A. Einstein, *Albert Einstein’s Theory of General Relativity*, G. Tauber, Crown Press, pp. 159–160.

And,

Physics too deals with mathematical concepts; however, these concepts attain physical content only by the clear determination of their relation to the objects of experience.

— Found in: “The Theory of Relativity,” *The Theory of Relativity*, Citadel Press, p. 5.

And,

Why is the equivalence of the practically-rigid body and the body of geometry—which suggests itself so readily—rejected by Poincaré and other investigators? ... Envisaged in this way, axiomatic geometry and the part of natural law which has been given a conventional status appear epistemologically equivalent.

— Found in: “Geometry and Experience,” A. Einstein, *Albert Einstein’s Theory of General Relativity*, G. Tauber, Crown Press, p. 161.

And,

First of all, an observation of epistemological nature. A geometrical-physical theory as such is incapable of being directly pictured, being merely a system of concepts. But these concepts serve the purpose

of bringing a multiplicity of real or imaginary sensory experiences into connection in the mind. To “visualize” a theory therefore means to bring to mind that abundance of sensible experiences for which the theory supplies the schematic arrangement. ...

— Found in: “Geometry and Experience,” A. Einstein, *Albert Einstein’s Theory of General Relativity*, G. Tauber, Crown Press, pp. 164–165.

3 Einstein, Heisenberg, and Charlie Chan

This next quote is recounted by Heisenberg about a philosophical claim Einstein made.

It is the theory which decides what we can observe.

— Found in: *Physics and Beyond*, Warner Heisenberg, Arnold J. Pomerans, trans. (New York: Harper, 1971), p. 63.

If I recall correctly, the context of this quote was from a brief discussion Heisenberg and Einstein had in 1926, directly following Heisenberg’s presentation of his famous Matrix Mechanics of quantum mechanics. Heisenberg boasted to Einstein that he predetermined to formulate his theory using only directly observable experimental values, and that he would not use concepts that required unobservable things, such as atomic orbits. To which Einstein was aghast. This baffled Heisenberg, as he thought such sentiments were at the heart of Einstein’s arriving as special relativity, and he told Einstein so. Einstein, having only a moment to consider his reply, rebutted that it may have been his thinking at one time, but it could not be so, and then he gave the quote above.

Although I think that Einstein’s reply quoted above is very important in its own right, I don’t believe it is the best reply he could have given Heisenberg. It’s as if Einstein intuitively realized that if Heisenberg could actually formulate a theory based solely on empirical data, then his two cherished philosophical beliefs would be severely challenged. The first of them is that there is no unnecessary logical connection between observation and physical theories, which, if correct, is good because then artificially intelligent machines will not put theoretical physicists out of work any time soon. More specifically, what Einstein meant is that one cannot merely uniquely deduce theories out of empirical data. You have to be creative in the process.

And second, Einstein probably intuited that Heisenberg had tacitly adopted the tenants of a formal point of view and therefore was not giving it its due credit in the invention of his theory.

I may be wrong, but I think the quote above can be given two distinct interpretations. The first, is that a particular theory under question can predict what ought to happen as well as proclaim what cannot happen. For example, with respect to the double-slit experiment where electrons are being passed through the slits, the Copenhagen interpretation of quantum mechanics only

ever allows one to speak of whole electrons making their way to the observation screen, never fractions of electrons.

But I think there is a second, and equally valid alternative interpretation of this quote, which can be expressed this way: *It's the theory we hold to by which we can (and cannot) interpret experimental results, or, indeed, whatever we observe.* Or put even shorter, *It's the theory that tells us what we observe.* As an example, to the believer in the Lorentz ether theory, the contraction of the moving rigid rod is interpreted as a real mechanical effect. But to the special relativist, it is interpreted nonmechanically as the lack of absolute simultaneity, when changing perspective from the rest frame of the rod to a 'moving' frame.

So, on the one hand, we cannot do physics without theories, but on the other hand, our accepted theories may bias us wrongly in our interpretations, and thus hold back progress. There is no *strictly* logical way to proceed out of this dilemma, except to keep an open mind.

One last ironic quote (as close as I can remember, anyway):

Theories like mist on eye glasses — obscure facts.

— Charlie Chan

And yet, without some presumptive theoretical framework to interpret observations, the so-called 'facts' have no meaning. And the apothegm, 'The facts speak for themselves' is therefore an enthymeme.

4 Conclusion

Oh, by the way, was Einstein always right about his philosophy of physics? First, I'm not even sure what that question means. Was he at least always consistent? Maybe, but I don't think so. I have some difficulty with a few of his views. Second: That's not the point of this essay. The point is that Einstein cared much about the application of philosophical considerations, especially epistemology, to the practical invention of theoretical physics.

//// End of physics with philosophy ////

You may breathe easy now.