



Contents lists available at ScienceDirect

Studies in History and Philosophy of Modern Physics

journal homepage: www.elsevier.com/locate/shpsb

Studying scientific thought experiments in their context: Albert Einstein and electromagnetic induction[☆]

Jan Potters^{a,*}, Bert Leuridan^{a,b}^a Centre for Philosophical Psychology, University of Antwerp, Belgium^b Centre for Logic and Philosophy of Science, University of Ghent, Belgium

ARTICLE INFO

Article history:

Received 16 November 2016

Accepted 13 April 2017

Available online 3 May 2017

Keywords:

Scientific thought experiments

Albert Einstein

Magnet-conductor thought experiment

Argument analysis

ABSTRACT

This article concerns the way in which philosophers study the epistemology of scientific thought experiments. Starting with a general overview of the main contemporary philosophical accounts, we will first argue that two implicit assumptions are present therein: first, that the epistemology of scientific thought experiments is solely concerned with factual knowledge of the world; and second, that philosophers should account for this in terms of the way in which individuals in general contemplate these thought experiments in thought. Our goal is to evaluate these assumptions and their implications using a particular case study: Albert Einstein's magnet-conductor thought experiment. We will argue that an analysis of this thought experiment based on these assumptions – as John Norton (1991) provides – is, in a sense, both misguided (the thought experiment *by itself* did not lead Einstein to factual knowledge of the world) and too narrow (to understand the thought experiment's epistemology, its historical context should also be taken into account explicitly). Based on this evaluation we propose an alternative philosophical approach to the epistemology of scientific thought experiments which is more encompassing while preserving what is of value in the dominant view.

© 2017 Elsevier Ltd. All rights reserved.

When citing this paper, please use the full journal title *Studies in History and Philosophy of Modern Physics*

1. Introduction

Since the publication of Mach's (1897) *Über Gedankenexperimente*, many eminent philosophers of science such as Alexandre Koyré, Karl Popper and Thomas Kuhn have shown interest in scientific thought experiments (scientific TEs, or STEs, for short). In the contemporary philosophy of science the focus is mainly on their role in the epistemology of science. Our focus on these epistemological issues is of a more indirect nature. We are concerned primarily with the way in which contemporary philosophers of science conceptualize and study the epistemology of STEs: How do they try to answer such epistemological questions?²

[☆]The authors would like to thank Peter Verdée, John Norton, Tim de Mey, the audiences of the VAF (Rotterdam 2015) and CLMPs (Helsinki 2015) conferences, and a number of anonymous reviewers for their valuable and insightful questions, comments, and remarks.

* Corresponding author.

E-mail address: Jan.Potters@UAntwerpen.be (J. Potters).

¹ Aspirant (Grant Number 1138716N) van het Fonds Wetenschappelijk Onderzoek - Vlaanderen (FWO - Research Foundation Flanders).

² This paper only concerns *scientific* thought experiments. It does not touch upon the issue of *philosophical* thought experiments.

We will proceed as follows. After a short sketch of the contemporary philosophical debate in Section 2, we will argue in Section 3 that there are two implicit assumptions about the epistemology of STEs underlying it. The case study in Section 4 will then show how these assumptions can be problematic. Norton (1991)'s analysis of Einstein's magnet-conductor STE, which functions as an example of these two assumptions is, in a sense, both misguided (the thought experiment *by itself* did not lead Einstein to factual knowledge of the world) and too narrow (to understand the thought experiment's epistemology, its historical context should also be taken into account explicitly). Based on this evaluation we propose an alternative philosophical approach to the epistemology of scientific thought experiments in Section 5. This approach is more encompassing while preserving what is of value in the dominant view.

2. The philosophical debate

2.1. James Robert Brown's platonic thought experiments

For Brown (1986, 1991a, 1991b, 2004, 2010, 2013), STEs are philosophically interesting because they deviate from the

epistemological norm in science: while “the great bulk of our knowledge must be accounted for along empiricist lines, [...] there is [...] the odd bit that is *a priori* and it comes from thought experiments” (1991a, ix). What is epistemologically peculiar about them is the way in which they lead us to a new and better understanding of reality: we make an *a priori inferential leap* from the thought experimental data to new knowledge of the laws of nature.³ This leap is special in two ways. First, it cannot be explained in terms of sensory experience, logical argument or theoretical simplicity (Brown, 1991b, 125–126). Second, it is very picturesque: the STE practically *shows* the truth of its conclusion to us (Brown, 2013, 57). This, for Brown, is why STEs form a special object of study for the epistemology of science.

To account for this, Brown draws an analogy with the epistemology of mathematics. The picturesque inferential leap experienced when one contemplates a STE is very similar, according to Brown, to how we gain mathematical insight. We acquire *a priori* knowledge of universal mathematical truths merely by looking at e.g. a ‘picture’ of a particular triangle (Brown, 1991b, 120). This can only be explained, he argues, by means of mathematical platonism (Brown, 1999): mathematical claims are true because there exist abstract mathematical objects, and we gain knowledge of them via our platonic intuition (Brown, 1991b, 121). The epistemology of STEs functions in a similar way. We gain *a priori* knowledge of the laws of nature merely by contemplating a particular picturesque scenario described in an STE. These laws of nature are true because of the existence of abstract objects: they are relations of necessitation holding between universals, in the sense of Dretske (1973), Tooley (1977) and Armstrong (1983). Our platonic intuition, which we need anyway to account for our mathematical knowledge, allows us to see these laws of nature, thus explaining our *a priori* knowledge acquisition when we contemplate particular STEs (Brown, 2004, 34).

2.2. John Norton's argument view

Like Brown, John Norton is primarily interested in the epistemology of STEs. His aim is to explain how “[t]hought experiments are supposed to give us knowledge of the natural world” (2004b, 44)⁴ or how “[t]hought experiments in physics provide or purport to provide us information about the physical world.” (1991, 129)⁵.

In contrast to Brown, however, Norton does not believe that STEs provide us with any *new* knowledge of nature: “[STE]s can only reorganize or generalize what we already know about the physical world and make it explicit” (Norton, 1996, 355). STEs, for Norton, are therefore *epistemically unremarkable* (1996, 334): they are nothing more than picturesque arguments (1996, 336) that lead us to knowledge of the natural world from premises consisting of “prior knowledge [which] rests eventually upon experience” (1996, 335). On this view successful STEs are, epistemically speaking, nothing more than deductive or inductive arguments, and this fully explains the “workings and achievements of any thought experiment” (Norton, 1996, 339). Norton summarizes his “eliminativist” and “reductionist” view on the epistemological functioning of STEs in the following two theses (see also 1991, 131):

- (1) “All thought experiments can be reconstructed as arguments based on tacit or explicit assumptions. Belief in the outcome-conclusion of the thought experiment is justified only insofar

as the reconstructed argument can justify the conclusion.” (1996, 354)

- (2) “The actual conduct of a thought experiment consists of the execution of an argument, although this may not be obvious since the argument may appear only in abbreviated form and with suppressed premises.” (1996, 354)

Norton thus intends his argument-view to explain both how STEs establish and justify knowledge claims (in the context of justification), and how we actually conduct them (in the context of discovery). When we contemplate an STE, we are in fact following the underlying inductive or deductive argument that, if sound, brings us knowledge of the natural world (Norton, 2004b, 49). Norton argues for this argument-view by showing how different STEs from the actual history of science can be reduced to logical arguments, and by conjecturing that this is possible for all STEs (1996, 339). We will consider one of Norton's argument-reconstructions in more detail in Section 4.2.

2.3. Tamar Szabo Gendler's experiments-in-thought

Like Brown and Norton, Gendler (1998, 2000, 2004) focuses on the epistemology of STEs (2004, 1152). For her, however, inferential approaches such as Brown's and Norton's cannot provide the full answer.⁶ Philosophers should not only explain how STEs can bring about scientific knowledge, but also how they provide scientists with adequate evidence and justification for such scientific knowledge claims against opponents disputing these claims. This is what she describes as their *demonstrative force* (1998, 400). She argues for this by showing how Norton's analysis of Galileo's free fall STE can explain how it leads to a knowledge claim, but not why the original STE in itself provided scientists such as Galileo with evidence and justification for that knowledge claim in their debates with Aristotelians. This shows, according to Gendler, that such an argument-reconstruction is *evidentially weaker* than the original: while an Aristotelian had ways to reject the conclusion of the reconstructed argument, this was not the case for the original STE (Gendler, 1998).

On her analysis of Galileo's STE, inferential approaches fail because they reduce the picturesque form of STEs to an inference. For the STE to have demonstrative force in the dispute between Galileo and the Aristotelians, we have to take into account that contemplating it essentially involves making a picture of the situation described (1998, 411). More in particular, when we contemplate an STE, according to Gendler, we in fact perform an “experiment-in-thought”: by means of the general non-propositional pre-scientific intuitions about the functioning of reality that we are endowed with, we play the mental picturesque scenario and see what happens. In this way, Gendler claims to be able to account for both the epistemological and demonstrative significance of STEs: because of their picturesque form and the role of our intuitions in their contemplation, they are more convincing than a mere inference in disputes about scientific knowledge (1998, 414–415).

³ Brown calls STEs that produce such knowledge of nature ‘platonic thought experiments’ (Brown, 1991b, 124–125).

⁴ See also (2004a, 1139).

⁵ See also (1996, 333).

⁶ That Norton has an inferential account is clear: for him STEs are nothing more than logical arguments. Brown's account can be described as inferential as well: when we contemplate an STE's scenario, we make an *inferential* leap from the thought experimental data to the laws of nature. While this is not a formal derivation, Brown still compares it to some kind of inductive inference and natural kind reasoning (2010, 46).

Download English Version:

<https://daneshyari.com/en/article/5130457>

Download Persian Version:

<https://daneshyari.com/article/5130457>

[Daneshyari.com](https://daneshyari.com)