Studies in History and Philosophy of Science 52 (2015) 20–34

Contents lists available at ScienceDirect

Studies in History and Philosophy of Science

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

Did Ptolemy make novel predictions? Launching Ptolemaic astronomy into the scientific realism debate☆

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ARTICLE INFO

Article history:
Received 24 December 2014
Received in revised form
12 April 2015
Available online 11 June 2015

Keywords:
Scientific realism;
Ptolemy;
Geocentrism;
Non-miracle argument

ABSTRACT

The goal of this paper, both historical and philosophical, is to launch a new case into the scientific realism debate: geocentric astronomy. Scientific realism about unobservables claims that the non-observational content of our successful/justified empirical theories is true, or approximately true. The argument that is currently considered the best in favor of scientific realism is the No Miracles Argument: the predictive success of a theory that makes (novel) observational predictions while making use of non-observational content would be inexplicable unless such non-observational content approximately corresponds to the world "out there". Laudan's pessimistic meta-induction challenged this argument, and realists reacted by moving to a "selective" version of realism: the approximately true part of the theory is not its full non-observational content but only the part of it that is responsible for the novel, successful observational predictions. Selective scientific realism has been tested against some of the theories in Laudan's list, but the first member of this list, geocentric astronomy, has been traditionally ignored. Our goal here is to defend that Ptolemy's Geocentrism deserves attention and poses a prima facie strong case against selective realism, since it made several successful, novel predictions based on theoretical hypotheses that do not seem to be retained, not even approximately, by posterior theories. Here, though, we confine our work just to the detailed reconstruction of what we take to be the main novel, successful Ptolemaic predictions, leaving the full analysis and assessment of their significance for the realist thesis to future works.

1. Introduction: selective scientific realism as a meta-empirical, testable thesis

Scientific realism (SR) about unobservables claims that the non-observational content of our successful/justified empirical theories is true, or approximately true. As is well known, the argument that is currently considered the best in favor of SR is a kind of abduction or inference to the best explanation, dubbed the No Miracles Argument (NMA). NMA states that the predictive success of a theory that makes (novel) observational predictions while making use of non-observational content/posits would be inexplicable, miraculous, unless such non-observational content approximately corresponded to the world "out there". In short: SR provides the best explanation for the empirical success of predictively successful theories. Empiricists such as Van Fraassen have argued that NMA is question begging, or simply has false premises, for there is another (at least equally good, according to them) explanation of empirical success, namely empirical adequacy. Yet, most realists feel comfortable replying that empirical adequacy provides no explanation at all, or at best an explanation that is inferior to (approximate) truth.

This comfortable position enters into crisis when Laudan (1981) brings pessimistic meta-induction back into the debate (brings it back, as one may trace pessimistic induction back to at least

☆ Research for this work has been funded by the research projects FFI2012-37354/CONSOLIDER INGENIO CSD2009-0056 (Spain), and PICT2010 No. 319 (ANPCyT, Argentina)/PIP No. 114-201101-00112 (CONICET, Argentina). We want to thank L. Laudan, S. French, B. van Fraassen and two anonimous referees for comments and criticisms to previous versions of this paper.

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http://dx.doi.org/10.1016/j.shpsa.2015.04.002
0039-3681/

Poincaré). Laudan reminds us that the history of science offers many cases of predictively successful yet (according to him) totally false theories, and provides a long list of alleged cases. Laudan's confutation, which is not a direct argument for antirealism but rather a rejoinder to NMA, is contested in different ways, among them that his list contains many cases in which the theory at issue was not really a piece of mature science or that it was fudged to make successful predictions. But not all cases could be so contested and realists acknowledged that in at least two important cases, the caloric and ether theories, we had successful *and novel* predictions made with theoretical apparatus that posits non-observable entities (the caloric fluid, the mechanical ether) which, according to the later theories that superseded them, do not exist at all, not even approximately. Realists accept that they must accommodate such cases and the dominant strategy for doing so is to become *selective*: when a theory makes a novel, successful prediction, the part of its non-observational content responsible for such a prediction need not always be the whole non-observational content. Indeed, many times it is only *part* of the non-observational content that is essential for the novel prediction, and it is *only* the approximate truth of *this* part that explains the observational success (some versions of selective realism may be traced back to Poincaré and Duhem).

We can summarize Selective Scientific Realism (SSR) thus: in really successful predictive theories (i.e. that make novel predictions) a part of the non-observational content, the part responsible for their successful predictions, is (a) approximately true and (b) approximately preserved by posterior theories which, if more successful, are more truth-like. SSR(a) explains synchronic empirical success and SSR(b) diachronic preservation (and growth) of empirical success. Importantly, SSR(b) makes the realist position empirically/historically testable; without something like SSR(b), SR would be merely testimonial: an assertion inaccessible to material assessment.

Different selective realists disagree on how to identify such realist parts, but this does not matter for our concerns here. What does matter is that, in order to be genuinely realist, any version of the SSR thesis must preserve its (meta-)empirical character: SSR is a (meta-)empirical thesis, i.e. an empirical thesis that is designed to explain a (meta-)empirical fact, namely the predictive success of science. No acceptable construal of the SSR thesis can make the realist claim a priori or conceptually true: SSR must be fallible, otherwise it would make justification and truth conceptually inseparable, thus becoming a form of antirealism. The selective realism claim is that, though fallible, both SSR(a) and SSR(b) are true. Since we do not have independent, non-observational direct access to the world to test SSR(a), the claim that is relevant for testing SSR as a meta-empirical thesis is SSR(b); and selective realists claim that the history of science confirms SSR(b). They maintain that the historical cases that count as confutations of, or anomalies for, plain, non-qualified realism are actually confirmative instances of its more sophisticated, selective reformulation SSR. Although caloric and ether theories are false, they are *not completely* false; each theory has a non-observational part that is responsible for the relevant novel successful predictions which (is approximately true and) has actually been approximately retained by its successor theory/theories. Thus, according to them history confirms SSR(b), the only testable part of SSR. Therefore, defenders of SSR conclude, SSR is an empirical thesis that, though fallible, is historically well confirmed.

This is the way in which SSR is committed to fixing any alleged anomaly. Confronted with an alleged case of a theory that made novel, successful predictions but—the opponent of SSR argues—whose non-observable content is not retained by the superseding theory, the selective realist must find a part of its non-observational content that is both: (i) sufficient for the relevant prediction, and (ii) approximately retained by the superseding theory. As an empirical thesis, SSR may face possible anomalies and the way it must fix them is always through this *divide et impera* move (Psillos, 1999). According to some (e.g. Chakravartty, 1998; Psillos, 1999; Worrall, 1989), SSR successfully fixed the caloric and ether anomalies, while according to others (e.g. Chang, 2003; Laudan, 1981) it has not done so (not yet, or not fully). The debate continues, and other anomalies are presented and discussed. For instance, the phlogiston case, initially dismissed as a pseudo-case but later acknowledged by some as a real, troublesome case and faced down in a similar SSR-friendly manner (Ladyman, 2011).

Our goal here is to launch a new case into the debate: geocentric astronomy. It was another item on Laudan's list (actually, the first one on his list), though it is often dismissed as not really making novel predictions, just accommodating known facts (e.g. Psillos, 1999: 105). We argue that this is not so. The no-novel-predictions tag attached to Ptolemy's astronomy is a consequence of the mere epicycle-plus-deferent accommodating mechanism‖ reading of the theory; a myth that, like all myths, is both popular and false. We find this case particularly useful because it is relatively easy to find the parts responsible for the predictions. In other cases, such as the caloric or ether cases, much of the discussion and disagreement between realists and their opponents concerns whether some non-observational part of the theory was really necessary for the relevant prediction. Was the solid, mechanical substance with orthogonal vibrations necessary to derive Fresnel's laws, from which the white spot prediction follows? Realists say "no" (to the mechanical substance); opponents say "yes". Was the material fluidity of caloric essential for Laplace's derivation of the speed of sound in air? Realists say "no"; opponents say "yes". And one finds similar controversies in other cases. In the case of Ptolemy, however, the contents responsible for the predictions are relatively easy to identify.

We take the Ptolemy case to be not only especially manageable, but also especially interesting. For here, the SSR strategy consisting of trying to find in the superseding theory a part that approximately retains the parts of the superseded theory responsible for the prediction seems prima facie particularly difficult, if not unpromising. Contrary to other cases (such as the caloric and ether cases) in which the contenders agree that *some* part is retained and the disagreement focuses on whether that part suffices for the relevant predictions, in this case it is hard to find any relevant retained part, thus making the realist case particularly contentious.

A detailed discussion and assessment of the significance of the geocentric predictions for the SSR debate is beyond the scope of this paper, however. Although in every case we eventually discuss some criticisms that might be addressed against it, and in the last section we briefly mention some immediate general criticisms that the realist might raise, we are not able to analyze and assess now in detail the different strategies that realists might try in order to overcome the difficulties that, at least prima facie, these cases pose for SSR. Nor we can analyze here the possible application to our case of some general realist strategies against alleged counterexamples (such as some suggested in Vickers, 2013). This goes beyond the limits of this paper and is left for future work. We confine our goals here to a more limited scope: merely to reconstruct in detail the Ptolemaic predictions and launch them into the scientific realism arena showing that this case deserves, at least prima facie, close attention. Although geocentric astronomy has often been referred to in the SR literature, to the best of our knowledge its alleged novel predictions have never been presented and analyzed in detail, not even by Laudan himself who, as we mentioned, puts it as the first item in his list (the theory is not even mentioned in the,