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Evandro Agazzi Ed. 2017. *Varieties of Scientific Realism*

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Putnam's formulation (1975) of the no miracle argument, and Putnam's (1978) and Laudan's (1981) pessimistic meta-inductive arguments reopened the centuries-old battle over scientific realism. Since then, all the theoretical paths in the discussion seem to have been explored. The publication, almost forty years after the origin of the discussion, of *Varieties of Scientific Realism*, a collection of contributions edited by Evandro Agazzi, inevitably raises the question: Is the scientific realism debate still alive?

Reviewing a collective work is objectively difficult because each of the contributions has its own particular features. In the case of *Varieties of Scientific Realism*, as its title makes explicit, the goal is to present a variety of contributions. As a consequence, a natural perspective on this book consists in raising two questions: Are the past achievements of the debate well represented? Are the debate's present challenges and potential developments indicated?

In order to answer both these questions, this review will follow the order of the book and end with a general assessment. The book comprises four parts: an introduction and prologue; a part dealing with general problems and arguments in the discussion of scientific realism and antirealism; a part discussing and defending "some recent conceptions of scientific realism"; and a part concerning realism in particular fields or disciplines.

In his contribution "Realism Today: Realism and Objectivity in Science", Mario Alai covers almost every aspect of the debate, namely the main arguments and the logical space of possible positions. He offers a very useful distinction between two debates which tend to be conflated under the label of "realism": the problem of scientific realism and the problem of scientific objectivity. These two problems result from two very different facts. The question of the knowability of unobservable objects follows from the recognition that our powers of detection are limited. The question of the eliminability of any subjective perspective on the world results from the observation that "knowledge is a function of two arguments, objective reality and subjective factors which precede and 'shape' our experience and cognition" (p. 38).

In his book *Scientific Objectivity and its Context*, published in 2014, Evandro Agazzi managed to develop a full theory of scientific realism. In the chapter he wrote for *Varieties of Scientific Realism*, "The Truth of Theories and Scientific Realism", he succeeds in presenting in a clear and structured way the main tenets of his book. He starts with the recognition that, in philosophy of science, objectivity has replaced truth as the cardinal value, and objectivity understood as intersubjective agreement has replaced objectivity as a property of an object. His goal is to reinstate truth as the main value of scientific theories, and to derive strong and weak objectivity from it. In order to do so, Agazzi (i) proposes a useful distinction between "things" and "objects": objects are structured sets of predicates, which are abstracted from concrete things; (ii) develops a three-level semantics. Then he explains how to understand empirical knowledge and theoretical knowledge.

Alan Musgrave is a prominent advocate of scientific realism. In a chapter entitled "Strict Empiricism versus Explanation in Science", he presents the debate and defends his own position. According to Musgrave, in agreement with Duhem, the central contentious point is the place of explanation in science. His point of view is that "it is reasonable to believe that the best (or only) explanation of certain phenomena is true". This principle is applied at the object level and the meta level. At the object level, current scientific theories are the best available explanations of phenomena, and hence they are true. At the meta level, scientific realism is the best explanation for the success of science. This conclusion is supported by two arguments: (i) The negation of this claim entails that we cannot explain phenomena, and therefore deprives the scientific endeavor of one of its main credentials; (ii) a response to Laudan's pessimistic meta-inductive (PMI) argument. Let me briefly recap the PMI: it has often happened in the past that empirically successful theories were later rejected, so that it is not reasonable to accept a theory as true on the grounds of its empirical success. Musgrave's response bears on two conceptual distinctions: partial truth vs. verisimilitude; empirical success as verified prediction vs. empirical success as novel prediction. With both these distinctions, his argument can be understood as the application of a two-step strategy: (i) the elimination of any theory that was devoid of novel predictions from the list of relevant historical cases; (ii) the demonstration that false theories that had genuine empirical success were partially true.

In general, this paper gives a good overview of the strategy commonly used to respond to Laudan's argument. Also, it attempts to link this debate to historical debates, including the relationship between science and religion.

Bas van Fraassen's "Misdirection and Misconception in the Scientific Realism Debate" claims that constructive empiricism has been misconstrued: it is neither an ontological claim nor a polemical claim. The real question is not: "What is there?" but "What is science?" and, more precisely, "What are the criteria of adequacy in scientific practice?" The ontological interpretation of the debate is rejected because factual questions are not philosophical. However, van Fraassen does not seem to realize that the question: "What are the criteria of adequacy in scientific practice?" is as factual as the question about the existence of electrons. He quotes as evidence a paper by Patrick Suppe (1998), who studies the ways in which scientific papers, *de facto*, argue.

Van Fraassen claims that one can be an antirealist while being gnostic, i.e. believing that scientific theories are true. According to Papineau's definition, used here by van Fraassen, the antirealist claims that it is impossible to know if theoretical entities exist, while the scientific gnostic thinks that our currently accepted theories are true. This analogy with religious belief is misguided. A religious believer can be gnostic about biblical content while thinking that there is no such thing as biblical knowledge. Such an attitude is rationally possible because his belief involves belief in a revelation. By contrast, if scientific knowledge is impossible, theories are arbitrary. Except in the case of someone who reduces the criteria of rationality to those of logical possibilities, such a position appears to be inconsistent.

Van Fraassen misrepresents the ontological realist's claim. The ontological realist does not automatically endorse the existence of unobservable entities. This commitment is the consequence of the association of an epistemological claim (which is philosophical) and a mix of empirical claims (experimental, historical, and sociological). The first proposition has the following form: "If the conditions C_1... C_n are met, scientists know the existence and the nature of the unobservable entities their theories describe". The second proposition asserts that the conditions C_1...C_n are actually met. Add the principle of factivity of knowledge (i.e. the knowledge that p entails p), and one cannot support epistemological realism and deny ontological realism.

It is because of his epistemology that van Fraassen does not admit a link between an ascription of a justified belief and the assertion of the existence of the truthmakers of the belief. Van Fraassen (1989) holds that any belief which is not irrational is rational. He thereby blurs the boundary, on the one hand, between what is rational and what is "arational" and, on the other, between what is rationally required and what is rationally permitted. The most important consequence of this move is that two opposite decisions can be equally rational.

Van Fraassen uses his epistemological theory to discard the view that inferences to the best explanation are necessary conditions for the rationality of theory acceptances. He admits that it is rational to accept the best explanation of a known fact. But his idiosyncratic epistemology enables him to deny that it is irrational to accept an explanation other than the best.

In "Scientific Realism: Representation, Objectivity and Truth", Michel Ghins first defends semantic realism and then sets out to support his own version of epistemic scientific realism. However, he refuses to use "wholesale" realism (Magnus and Callender 2004) or "recipe-realism" (Saatsi 2016), and in particular he refuses to use the no miracle argument. If scientific realism is defined as the identification of the good reasons (or arguments) scientists have for accepting the truth of current scientific theories, "the challenge for the realist is to formulate criteria for selecting objects posited by our theories which deserve to be called 'real'" (p. 119). Once these good reasons are identified, the task is to determine what parts of our theories are justified by these reasons.

The central question any endeavor of this kind raises is that of the justification of the justification criteria. Are there good reasons for believing that a given reason is a good reason? Ghins solves this problem with the help of two different facts. First, he draws on a historical case of a successful argumentation for the existence of unobservable objects, namely Perrin's famous case for the existence of atoms. He abstracts from this case four general requirements for arguments. Second, Ghins derives from semantic realism the impossibility of believing in the infallibility of current scientific theories: no mental content, even the best reason, is infallibly correlated with truth, since truth is an absolute property of a statement.

In a chapter entitled "Robustness and Scientific Realism", Marco Buzzoni's starting point is the lack of cogency of Smart's cosmic coincidence argument, even in Putnam's (1975) and Hacking's (1983) reworked versions. He also follows Woodward's (2006) recommendation to distinguish between different concepts of robustness. Buzzoni contends that, in order to make Smart's cosmic argument work, one has to avoid "the opposite error of neglecting important similarities between these different kinds of robustness" (pp. 139-140). He shows that robustness as consilience and robustness as stability should be understood as interdependent.

The form of Thomas Nickles' paper, "Cognitive Illusions and Nonrealism: Objections and Replies", is an interview with the author by himself about his own views on scientific realism, namely non-realism and cognitive illusions. However, it is difficult to grasp the originality of his view. Substituting the label "antirealism" for "nonrealism" is only a verbal move, since their definitions are identical. According to the author, "[w]hen it comes to deep, postulatory theories, I am a nonrealist. I deny that we have sufficient evidence and argument to conclude with confidence that even our most mature theories are true, or very nearly" (p. 151); this is nothing other than epistemic antirealism. As for "cognitive illusions", this is nothing more nor less than a reformulation of what could be called the Pyrrhonian version of the pessimistic induction argument (Künstler 2012; Wray 2012).

Instead of dealing directly with the scientific realism debate, Fabio Minazzi's contribution "The Epistemological Problem of the Objectivity of Knowledge" grapples with the general problem of defining objectivity. Following the historical order, the author recapitulates different solutions that have been offered to this problem, from Kant to Preti's neo-realism.

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Gerhard Vollmer, in a chapter entitled "Why Do Theories Fail?", sets out to present "the best argument for realism". In a nutshell, he argues that only realism can explain why scientific theories fail. The premises of his argument are:

(1) A true theory cannot fail (i.e. be rejected).
(2) Anti-realism does not explain why theories fail.
(2a) Anti-realists do not talk about it.
(2b) Anti-realists cannot explain it.

The problem with Vollmer's argument is that both these premises are false. (1) A true theory can fail and be rejected for a long time by the scientific community (e.g. Copernicus's theory, Mendel's theory, Wegener's atomist theory, Darwin's theory). This is possible because a scientific theory cannot be applied to phenomena without auxiliary hypotheses and models.

(2a) Vollmer wonders why antirealists wonder "why did Putnam, van Fraassen and most other realists (*sic*) put up with the *success* of realistic hypotheses, theories and so instead of referring to their *failures*?" Since Laudan's paper, most of the literature has been devoted to precisely this problem. Even Poincaré and Duhem have tried to give a response to it.

(2b) Anti-realists do provide explanations for the failure of theories. For instance, it is often claimed that the explanation for the failure of a theory is that it postulated entities whose existence was not empirically grounded, which were used to make empirical predictions. Another explanation is that a theory is not empirically adequate. The motivation for accepting a theory is only its ability to derive true empirical regularities. Often a theory predicts unobserved empirical regularities. Thus, if these predictions turn out to be false, the theory should be rejected. Scientific anti-realists accept the existence and knowability of empirical regularities, since they do not reject empirical knowledge.

The failure of Vollmer's argument springs from confusion as to what scientific realism is. He distinguishes between three varieties of realism: ontological, epistemological and methodological, and yet he discusses these varieties without taking this distinction into account. For instance, it is unclear whether his best argument is for ontological, epistemological or methodological realism. The fact that past theories were rejected might be a reason to believe in a mind-independent reality, but this consideration is not an argument for "methodological realism". On the contrary, the author seems to ignore the fact that the most important of the antirealists' arguments draws on the fact of past failures of science in order to cast doubt on current scientific theories.

In a chapter entitled "Scientific Realism and the Mind-Independence of the World", Stathis Psillos does not, surprisingly, deal with the epistemological claim of scientific realism, as he did in his previous work, but with its metaphysical claim that: "The world has a definite and mind-independent structure" (p. 209). He has previously put forward the defence that this claim should be understood as licensing "the possibility of a gap between what there is in the world and what is issued (...) as existing by a suitable (even ideal) set of epistemic practices and conditions" (p. 210). He contends that neither idealism nor verificationism allows for this "possibility of divergence". He therefore adds two necessary conditions for mind independence: "irreducible existence", in order to exclude idealism, and "objective existence", in order to exclude verificationism.

Steven French's "Structural Realism and the Toolbox of Metaphysics" is a response to Saatsi's (2016) charge against what he calls "recipe realism". First, let me outline Saatsi's claim in order to contextualize French's response. "Recipe realism" aims to find a procedure, applicable to any scientific theory, which can identify the epistemologically safe parts of those theories. Saatsi offers three main arguments to support his criticism: (*non-projectibility*) "recipe realism" inductively justifies its algorithms by blindly treating scientific theories as homogeneous; (*relativism*) there are many contradictory versions of such recipes; (*non-informativity*) the recipes do not help us to know what theories say about reality. He contends that "recipe realism" should be replaced by an "exemplar-driven realism", conceived as a "positive attitude" which, in every case of theoretical change, searches for invariant elements whose presence explains the experimental successes of the discarded theory.

French agrees with Saatsi's rejection of "recipe realism", but he denies that such rejection implies renouncing structural realism. In order to rebut this implication, he tries to show that structural realism should be seen as an item belonging to exemplar-driven realism. Scientific realism avoids the non-projectibility objection, since it is a theory about the theoretical content of quantum theory, quantum field theory and high-energy physics, which are all related. The structural realist avoids the relativism objection, since formal tools (Ramsey sentences, set theory or category theory) are only tools of representation. The non-informativeness objection is blocked by the fact that, for each theory, the notion of structure is introduced for specific reasons: the problem of underdetermination in the case of quantum physics; Poincaré's symmetry in that of quantum field theory.

French goes further than Saatsi. The exemplar-driven approach is exposed to the danger of being redundant by comparison with a plain scientific evaluation or the historiographical reconstruction of theories. Why is this approach still a *philosophical* approach? According to French, the philosopher's task is to ascertain the metaphysical implications of these theories. How can metaphysics help to understand science? French identifies three options: science replaces metaphysics, metaphysics replicates scientific notions, or metaphysics is a toolbox to understand science. He advocates this last approach, and gives an illustration by discussing how the structural view can be cashed out in terms of the classical determinable/determinate distinction or in terms of Paul's (2012) "mereological bundle theory".

Although it only appears in the fourth section of the book, Amparo Gómez's paper, "Causation and Scientific Realism:

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Mechanism and Power without Essentialism", illustrates French's conception of metaphysics as a toolbox. Gómez investigates what the metaphysical commitments of a scientific realist should be. In particular, she wonders if one can accept a dispositional ontology without subscribing to essentialism.

In "Retention, Truth-Content and Selective Realism", Alberto Cordero discusses the latest developments in the selectivist strategy to undermine the pessimistic meta-induction. This strategy goes like this: in order to retain the epistemic value of the empirical success of scientific theories in spite of the fact that successful theories often fail, the strategy sometimes called "divisionism" attempts to distinguish between the working posits and the idle posits of these theories. This strategy is intuitively appealing. However, its accomplishments are quite deceptive. As Vickers (2013) writes: "Even if the 'working posits' of contemporary science cannot be prospectively identified, it remains possible that we might develop a recipe for identifying certain idle posits" (Vickers 2013, p. 209). This kind of response to the pessimistic argument is far from being optimistic. A useful recapitulation of the history leading to such a gloomy conclusion enables Cordero to identify the cause of this (at least apparent) failure in the selectivists' minimalist constraint. Selectivists look for the minimal ontological commitment: they try to accept only the theoretical parts that are necessary for the derivation of successful empirical predictions. Cordero therefore contends that a naturalistic approach to science, which applies a scientific criterion of scientific acceptance to scientific theories (instead of a philosophical one), justifies the adoption of a less drastic ontological diet.

Hans Lenk, in "A Scheme-Interpretationist and Actionistic Scientific Realism", claims that over-determination of our experience by what he calls "scheme-interpretation" is unavoidable.

The third part of the book sets out to determine how the scientific realism debate can be formulated in the context of particular sciences: semantics (Jan Woleński), quantum mechanics (Dennis Dieks and Roland Omnes), cognitive science (Jean-Guy Meunier and Lektorski) and mathematics (Gerhard Heinzmann and Reinhard Kahle).

In my opinion, the book holds promise in its overview of the "varieties of scientific realism", its past achievements, and its future directions. The organization of the book is well thought out and user-friendly. The book is useful for newcomers to the field, since it helps to provide a sense of the diverse directions of the realism debate. It is also useful for researchers, as many of its chapters discuss recent ideas in realism and provide a new impetus for further discussion.

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