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## Book Review

### Pierre Duhem: Between Physics and Metaphysics

Víctor Manuel Hernández Márquez (Ed.) *Pierre Duhem: Entre física y metafísica*. Universidad Autónoma de Ciudad Juárez and Anthropos Press, 2016. 208 p. 14 € - ISBN 978-84-16421-36-7

#### Reviewed by:

Dámian Islas Mondragon<sup>1</sup>

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This book is structured by seven chapters written by six researchers from three different Universities: Fábio Rodrigo Leite y João Cortese from the Universidade de São Paulo, Brazil; Ambrosio Velasco Gómez from de Universidad Nacional Autónoma de México and Víctor Manuel Hernández Márquez (coordinator), Roberto Estrada Olguín and Roberto Sánchez Benítez from the Universidad Autónoma de Ciudad Juárez, Mexico.

Each of the authors develops their own analytical perspectives around the work of Pierre Duhem (1861-1916). Ambrosio Velasco seeks to show that the contemporary philosophy of science began from a fundamental criticism of the modern conception of scientific rationality proposed by Descartes (in his rationalist version) and by Newton (in his empiricist turn). Velasco contends that Duhem's contribution to this discussion is to have undermined several myths and dogmas, among them, the Cartesian idea that the rationality of knowledge is based exclusively on strict adherence to certain methodological rules and the Newtonian thought that observation, induction and experimentation are the fundamental procedures of the scientific method.

Although several authors discussed the relevance of the method of composition or synthesis developed by Newton, as J. F. Herschel and W. Whewell did it at the beginning of the 19th century, Velasco argues that the strong empiricist commitment of Newtonian methodology was never questioned on its "foundational basis". Indeed, in his classic work *La Théorie Physique. Son Objet, sa Structure* (1906), Duhem pointed out the inconsistencies of the methodology proposed by Newton in relation to the inductive generation of scientific hypotheses and the limitations of empirical testing methods. At the end of his chapter, Velasco analyzes the influence of Duhem on some contemporary philosophers of science, including Otto Neurath, Karl. R. Popper, Thomas S. Kuhn, Larry Laudan and Imre Lakatos.

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<sup>1</sup> Dámian Islas Mondragon is a Professor at the Universidad Juárez del Estado de Durango, México. Address: Boulevard del Guadiana No. 501, Ciudad Universitaria, C.P. 34120, Durango, México. Email [damianislas@ujed.mx](mailto:damianislas@ujed.mx). Orcid: 0000-0001-8538-6835

According to Velasco, Popper's *Logic of Scientific Discovery* (1935) is a response to the problem of the empirical sub-determination of theories formulated by Duhem. Popper's response to this problem is twofold, (i) that scientific evidence is theoretically dependent and (ii) that scientific evidence is ambiguous. Indeed, Popper defended point (i) without recognizing Duhem's influence on the matter; while point (ii) was not explicitly addressed by Popper but only indirectly in recommending not to "save" the hypothesis in the face of a major refutation. However, Popper's recommendation has to do with certain adjustments – drastic or not (Quine, 1951, 43) – within the theoretical system in order to maintain some theoretical statements. It seems to me that Duhem's argumentation on the matter is more modest by merely suggesting that when there is any conflict with experience, what is refuted is necessarily ambiguous.

In relation to Duhem's influence on thinkers such as Kuhn, Lakatos and Laudan, Velasco contends that the main idea that these philosophers inherited from Duhem is that "philosophical interpretations of science must be based on the analysis of the history of science" (2016, 39). However, Velasco ends by arguing that, with the exception of Kuhn, Lakatos and Laudan resorted to the formulation of methodological meta-rules to ensure not only the rationality of isolated scientific theories; but also the rationality of the research traditions that constitute the very history of science. In other words, both authors ended up "sublimating" the rationality they criticized in order to submit history to its own methodological meta-rules.

In his work, João Cortese seeks to show the common elements between Blaise Pascal and Duhem. According to Cortese, one of the resources that scientists resort to is the use of analogy, which is perceived through the "spirit of fineness". However, Cortese argues that Duhem goes too far in his distinction between the spirit of fineness – which Duhem associates with the heart and the immediate intuition – and the spirit of geometry – tied to reason and deduction. Pascal, from whom Duhem inherits these two concepts, certainly does not conceive this distinction in this way. In particular, the spirit of geometry is not specifically related to principles and deductions.

As is well known, Duhem's conceptual separation between physics and metaphysics (origin of the title of this book) is not a positivist distinction between what makes sense and what does not. In fact, it is a distinction between two legitimate types of scientific knowledge, that is, if physics deals with the description of experimental laws, the task of metaphysics is to show the reason for those laws, says Cortese (2016, 48). And this is how the analogies allow us to understand that scientific development is a progressive transit towards the attainment of a natural classification. Thanks to the spirit of fineness, scientists can "realize" the analogies and the tendency towards the natural classification that science follows; even though, Cortese argues, scientists are not able to logically explain how this could happen (2016, 65).

In his work, Víctor Hernández delves into the role that the concept of 'analogy' has in Duhem's work in relation to intuition and deductive reasoning. Hernández contends that Duhem uses the analogy to solve the tension between physics and metaphysics, without dropping the idea that physical theory is autonomous of any metaphysical system. Hernández argues that there are two basic meanings of the concept of 'analogy', the first as a heuristic resource in the construction of theories and as a bridge between theoretical physics and experimental physics. The second, as a cosmological (or metaphysical) tendency of science that seeks the final explanation of things.

According to Hernández, physics is confined to a set of mathematical claims deduced from a small number of principles that seek simple, complete, and exact representations of experimental laws. However, when logic is insufficient to elaborate this mathematical representation, scientists draw analogies (2016, 81). In these heuristic stages of science, when there are no clear methodological rules, analogy constitutes, according to Duhem, a "sure and fruitful method." Finally, Hernández points out that the contingent use of analogy in Duhem is different from that of Ernst Mach, for whom analogy occupies a "more prominent place in science" (2016, 84).

The most provocative intervention is that of Fábio Rodrigo Leite who argues that the logical analysis of scientific theories shows that it is not possible to obtain any kind of definitive or true knowledge due, among other reasons, to the fact that truth is not guaranteed *a posteriori* by the physical phenomena nor *a priori* by the claim of the universality of scientific statements. According to Leite, the value of science for Duhem is merely practical, that is, science has no relation to the "ultimate causes" that metaphysics studies. So, metaphysics functions as a regulatory idea that allows the "convergence" of science, avoiding relativism.

Leite proposes a Duhemian taxonomy that distinguishes, on the one hand, between metaphysics and cosmology and, on the other hand, between experimental and theoretical physics. In his essay "Physique et métaphysique" of 1893, Duhem accepted the model based on the notion of efficient causality

which allows the transit between physics and metaphysics. However, later, in his 1905 essay "Physique de Croyant", Duhem gave up the possibility of a causal transition from one to the other, replacing it with the notion of 'analogy'. Besides, the religious theme that Duhem left aside in 1893 is included, along with the theme of 'faith', in 1905.

Experimental physics studies three phases, namely, the fact finding, the discovery of its laws and the construction of theories. By other side, there are three degrees of our knowledge of the world, namely, the first degree refers to isolated and even confused facts collected by experience. The second degree is constituted by the knowledge of the purely experimental laws obtained by induction. According to Leite, what we may call the "first" Duhem certainly wavers about the certainty we can get from the general laws obtained by induction (2016, 92-93); while the "second" Duhem confers an absolute degree of certainty to induction. The third degree is obtained through theoretical hypotheses whose terms lack any kind of reference.

Leite's idea is that, although the theoretical laws depend on the laws of common sense, they are not determined by the latter, given that, in this epistemic stage, scientists "are free to choose – in the way that best suits them – their favorite representations" (2016, 96). It is worth noting that raw data from the first stage do not "depend" on theoretical knowledge; but "constitute" it. Certainly, the interpretation developed by Leite is close to the notion of 'hard core' of the scientific research programs developed by Imre Lakatos. In Leite's words: "Maintaining induction at the level of the laws of common sense allows Duhem to establish an immovable basis upon which all empirical knowledge can be erected" (2016, 97).

In order to gain access to the essential knowledge of inanimate matter, Duhem argues that we must begin with the study of effects (of which physics is responsible) and its causes (of which metaphysics is responsible). So, the study of physics precedes the study of cosmology and thus, physics can dispense with metaphysics and be founded autonomously. Note that this cause-effect thesis creates some tension with the Duhemian notion that metaphysics functions as a regulatory idea that allows the "convergence" of science and avoids relativism. That is, as a regulatory idea, physics cannot "do without" metaphysics, especially thinking, as Leite shows us, that physics and metaphysics have a common point in experimental data. For this tension to fade, we have to take into account the evolution of Duhem's thought that transits from these Thomist terms of cause' and 'effect', towards a more constructive version that emphasizes the dialogue thesis.

The last part of the book consists of three historical studies. Roberto Estrada makes a historical inquiry about the origin and nature of the notion of "saving the phenomena" in science. As is well known, the problem is that different hypotheses may be equally suitable to represent the same phenomenon. Estrada argues that it is not at all clear when exactly this concept was formulated for the first time. The only certainty is that it began to be used at the beginning of the Christian era. In his work, Roberto Sánchez also makes a historical inquiry around Duhem's studies on Leonardo Da Vinci. In general, Sanchez traces the sources from which Leonardo developed his scientific ideas, as well as the way in which the thought of this genius influenced the development of certain aspects of the science of his time.

Finally, Víctor Hernandez outlines the possible relationships between the philosophical positions developed by Louis Couturat and Duhem. Hernandez holds that, since an analogy is a type of inductive argument, there are at least two reasons why Duhem's demonstration by *reductio ad absurdum* of the principle of mathematical induction would not have been accepted by Couturat. The first reason is that the proof developed by Duhem ignores the achievements of the new mathematical logic of his time. The second is that such proof must show that the principle of induction is analytic in the sense that it accomplishes with purely logical concepts and axioms. Indeed, Duhem's emphasis on logic within physical theory brings him closer to English contemporary logicians, says Hernandez (2016, 190), forcing us to reexamine the nature of his supposedly "conventionalist" stance based in the Duhemian hypertrophy around the spirit of fineness to the detriment of the spirit of geometry.

In general, the book offers a clear line of research that serves as the guiding thread along the seven chapters, expressed accurately in book's title: Pierre Duhem: between physics and metaphysics. Although each one of the texts approaches the subject from a different angle, it is possible to appreciate certain dialogue between the authors. The depth and conceptual clarity with which each author develops his arguments, shows us that each one of the texts is well documented. The book exhibits an expository cadence that is the result of the thematic coherence demanded in a text written for specialists in the subject.