

Transversal: International Journal for the Historiography of Science, 2 (2017) 112-126

ISSN 2526-2270

www.historiographyofscience.org

© The Author 2017 – This is an open access article

Dossier Pierre Duhem

Bon sens and noûs

Roberto Estrada Olguin¹

Abstract:

This paper is intended to link the notion of *bon sens* with the Greek notion of *noûs*, that exposes the role played by the first notion in the thought of Pierre Duhem and explains the concept of *noûs* in the thought of Aristotle. Later, it attempts to carry out the explanation of the link that can have both notions.

Keywords:

Pierre Duhem; *bon sens*; *noûs*; science; philosophy; history of science

Received: 30 March 2017. Reviewed: 15 May 2017. Accepted: 30 May 2017.

DOI: <http://dx.doi.org/10.24117/2526-2270.2017.i2.11>

Introduction

The significance of a thinker can be measured by the number of defenders and critics of his thought. If we use this measuring scale of transcendence, we can see that Pierre Duhem is located at the highest levels of transcendence. The meaning of the word transcendence is “to overpass”, the transcendental and the transcendent is what is beyond, which go beyond; the thought of a human being can be transcendent and transcendental because it exceeds and goes beyond the time in which it is produced; to exceed and go beyond the moment in which something has arisen can be done to the back or to forwards, this is meant in the case of the time you can go beyond the present to the past or to the future. The thought of Pierre Duhem is transcendental and transcendent in that sense because it goes towards the past and the future.

The thought of Duhem, like the thought of all great thinkers, goes to the past because it comes from a tradition and moves towards the future so it becomes a classic. We can go back and forward through time because we think about the issues that belong to both the past and the present as well as the future. The problems that Duhem deals with, are those that belong to the three times. In this paper, I try to address one of these problems: the question of the *bon sens*. This matter has been studied by many specialists who have devoted much time to the study of the thought of the French thinker, which will be mentioned throughout this work. Here I intend to address the issue from a unique perspective. In fact, I will try to study the *bon sens* going toward the past and the future.

To carry out this, I tried to follow retrospectively the footprints of the tradition of which it may come from the notion of *bon sens* and I came up with the Greek notion of *noûs* and explained how they can be

¹ Roberto Estrada Olguin is a Professor in the Department of Humanities at the Autonomous University of Ciudad Juárez. Address: Av. Universidad y Av. Heroico Colegio Militar S/N Zona Chamizal C.P. 32300. Ciudad Juárez, Mexico. Email: estradaa6@hotmail.com

linked these two notions. If this attempt is successful, then we can show that the question of the *bon sens* is one of those that belongs to the three moments in time. To state as clearly as we can, according to the scholars of this kind of thought pointed out the importance of the issue that we are dealing with in the system of thought of Duhem; subsequently, I expose the link that can be established between the thought of Pierre Duhem and the tradition, in particular with the Greek thought and, more specifically, with the notion of *noûs*; finally indicated how we can show the transformation of the Greek notion of *noûs* to become the notion of *bon sens*, through the changes experienced by the western tradition.

The *Bon Sens* in the Thought of Pierre Duhem

Russell Niall Dickson Martin (1991, 6-13) has pointed out that to understand both the reception of the works and to understand the thinking of the historical figure Pierre Duhem, it is necessary to consider both the internal and external factors. Among the external factors mentioned the religious, the political and the philosophical context. Among the internal factors mentioned "the method of working" and "the habits of publication of Duhem" (Martin 1991, 193-199). Martin explains the work method of Duhem and asserts that he had to pay a price for the ease of writing, resulting in a single draft without notes and had to pay an even higher price by having to produce a complete form with their results in the atrocious conditions of isolation in Bordeaux and with a single opportunity to consult all the manuscripts that he wanted. "It was all done on the run with no chance to reflect", and without the opportunity to make changes that affected the integrity of his work, "changes of view sometimes both exaggerated and partially concealed by Duhem's publication habits".

On the other hand, according to Martin, the publishing style typical of Duhem consists of literal reprints of a series of articles that appeared in a journal, adding prefaces. For example, as was the case of the work entitled *Les origines de la statique* that were first published in the *Revue des questions scientifiques* from autumn 1903 to at the end of the year 1906. According Martin, there is evidence that the same composition methods are followed in other works of Duhem, particularly, in *La théorie physique*; "There can be little argument that this was how the *Études* was written, and a detailed analysis of the *Système* would certainly reveal evidence of similar methods of composition, though here the scale of the work probably made it inevitable." This habit of publication is played by Martin as a publication of the work before being completed. The consequences of these habits are summarized by this critical as follows: "at worst unperceived changes of view during composition, works started before I knew where his argument was going to lead. Changes in overall attitudes during his career, writing liable to mislead the inattentive reader into serious misreadings" (Martin 1991, 194-195).

The shifts in perspective not recognized are as suggested in the above quote, the most important consequences of "the habits of publication" and "the method of working" of Duhem. In fact, Martin believes that these changes in point of view in the works of the French physicist have consequences, one is the way his works were received and, the other is if we are trying to understand his thinking, we must understand the changes. Some of these changes have been identified in the book of Martin as cited above, one of them mentioning:

During this essay, I have pointed out many examples of such shifts. Lemonnier's example of Albert of Saxony is one case: after initially seeing him as an original contributor to mediaeval mechanics Duhem later saw him as a repeater of the ideas of others. Another is the change of focus in *To save the phenomena* from methodology to cosmology. Yet another is the shift in the *Système du monde* from cosmology to the overall relations of physics with philosophy and theology. These shifts affect individual works, but there is one that may have caused more trouble than any other: the increasing emphasis on the Pascalian methodology of *bon sens* as Duhem's career progressed. (Martin 1991, 196)

According to the above quote, the Pascalian methodology of the *bon sens* was taking greater importance to the extent that the thought of Duhem progressed and this change of importance of the *bon sens* is the change of perspective that has most concerned and disturbed the understanding of the thought of the French Catholic thinker. In this way, we have come to the central point, which is the interest of this

small written: the origins of the concept of *bon sens* in the thought of Pierre Duhem. However, we must point out that we do not intend to confine ourselves to the thought of Pascal as the source of the *bon sens* in the thinking of Duhem. We believe that the influence of Pascal on the thought of Duhem has been sufficiently demonstrated by the research of various authors interested in the thought of the latter². Instead I try "to speculate" about the remote source and implicit of the *bon sens*, which is also the source of thought of Pascal: the western thought, resulting from the merger of Christianity and the pagan Greek thought. I think that despite the prominent role of the apologetic aspect of the thought of Duhem, the Christianity and particularly, the Catholicism has not received sufficient emphasis on its relationship with the notion of *bon sens*, to which this essay aims to contribute.

Of course, we say that we intend "to speculate" to the extent that in our exposure there are a high degree of conjecture, and in any way, I intended to present this exposure with demonstrative character. In addition, I should point out that I do not intend to draw the complete history of the transformation of the concept of *noûs* going through each of the links until become the *bon sens* which requires a much broader dimension than this little essay. In revenge, I intend to provide some evidence suggesting that the *bon sens* is in part the result of the transformation of the Greek concept *noûs*.

Bon Sens, Science, Philosophy and History in Duhem

Before anything else, it is necessary to have a brief overview of the influence not only of the thought of Pascal on the general thought of Duhem, but also an overview of the reasoning of the physicist of the 19th century. This overview will provide us the opportunity to locate the place of the *bon sens* within the general thought of Duhem. Jean-François Stoffel, who has been devoted to the study of the relationship between the thoughts of both these thinkers, besides he emphasizes the various topics in which we can find evidence of such relationship³. He has pointed out that it is not enough with the mention of scattered topics, besides we required, in one area, observe the influences of which there is no textual evidence and, on the other hand, we need trying to gather the scattered influences in the center of a global system of thought, because "it seems to us that an influence so proven and so extensive can't in an author like Duhem be limited to a succession of particular subjects, but must indicate a much more fundamental existence of a vision of the common world which is both scientific, philosophical and religious" (Stoffel 2007, 293)⁴. For our part, we can add that, this "vision du monde" also extends to the historical.

In addition, in a previous piece of work Stoffel has pointed out the problem of the historical paradox that Duhem always want to be known and recognized as a physicist and, however, history has played a joke, because it has been better recognized in the intellectual context as a philosopher of physics and as a historian of science, to the side of Paul Tannery or Alexandre Koyré, but not as a physicist, to the side of Max Planck or Einstein (Stoffel 1995, 49-50). In the light of the studies that have been developed on the thought of Duhem from Abel Rey and up until the present, and despite the efforts of the own Duhem to be recognized as a theoretical physicist, we can point out that the history not only has not recognized Duhem as theoretical physicist, but also that when it is recognized as a philosopher of physics and as a historian of science it is almost always associated with claims apologetic.

² The influence of thought of Pascal on the thought of Duhem has been highlighted by the latter's own contemporaries such as his own daughter H  l  ne as well as by friends and acquaintances. More recently, since 1991 Martin pointed out that influence and from 1993 Stoffel has been working in that direction. Cf. H  l  ne Pierre-Duhem 1936; Martin 1991; Stoffel 1993; 2002; 2007.

³ Stoffel mentions the following topics in which there is textual evidence of the influence of the thought of the philosopher of the 17th century on the thought of the scientist of the 19th century: the critique of mechanism, the capabilities of human intelligence, the different types of spirits, the research of a via media between realism and a dogmatic skeptical phenomenalism, the management of knowledge, the truth of the first principles as well as the inability to define everything and, finally, the philosophy of history optimistic and providential (Stoffel 2007, 287-293).

⁴ "Il nous semble qu'une influence aussi av  r  e et aussi   tendue ne puisse, chez un auteur comme Duhem, se limiter    une succession de th  mes particuliers, mais qu'elle doive signaler, entre les deux penseurs, l'existence, beaucoup plus fondamentale, d'une vision du monde commune qui est    la fois scientifique, philosophique et religieuse" (Stoffel 2007, 293).

Let us add that, in relation to the global system of thought, it has been always highlighted the extra-scientific influences about the thought of Duhem; in this sense, looking for Ariadne's thread that guide the understanding of the global thought of the French physicist, R. N. D. Martin has pointed out a "hidden agenda" in which items are found religious, cultural and political factors that have influenced the thought of Duhem⁵. The global system of thought of Pierre Duhem, like that of any thinker, we can approach it from the following general themes which, furthermore, are also the subjects in which it has been pointed out the influence of thought of Pascal: the scientific, philosophical, historical and religious.

The Scientific Aspect

In the discussion on the existence or not of an antagonism between science and religion, in the words of the own Duhem, between *l'esprit scientifique* and *l'esprit religieux*, in his famous letter to Bulliot of 21 May 1911, Duhem notes that the defenders of the existence of such antagonism argue that the logical analysis reveals the radically different methods by which science (rigorous that part of axioms and checks by the experience) and religion (aspirations and intuitions, vague) are produced; however, Duhem thinks that the antagonism between the methods of one and another is apparent. In accordance with Duhem, this opposition between the methods of both human activities is due to a superficial and false analysis of such methods. But to him who has penetrated to the heart and has captured the vital principle of the methods, captures what provides its diversity and what keeps together these united procedures.

It sees a same human reason use the same means essential to arrive at the truth; but in each domain, this reason is adapted to the use it makes of these means to the special object from which it wants to acquire the knowledge. [...] It is recognized then, that to get to the truths of religion, human reason does not employ other means than those that has served to achieve the other truths; but she uses it in a different way, because the principles from which part and the conclusions to which it tends are different (Hélène Pierre-Duhem 1936, 164-165).⁶

115

In addition, in a letter to Joseph Récamier which is quoted partially by Picard, Jordan, Jaki and Martin without identifying the receiver, but that Stoffel has identified by Hélène, the daughter of Duhem⁷, shows that the latter not only affirms the use of the same human reason in various orders of knowledge, but also takes the same point of departure; in such a way that the so-called radical difference of the procedures is only apparent:

To force to reflect on these difficulties, I have come to realize that it can say the same of all sciences, from those that are taken as the most rigorous, physics, mechanics, even the geometry. The fundamentals of each of these buildings are made of notions which it claims to understand, despite they will not be defined; of principles that are insured, despite it not having any demonstration. These

⁵ In the same sense of "hidden agenda", Michel Puech (1996) points out that the history of the sciences of Duhem is a "crypto-theology of Providence".

⁶ "Il voit une même raison humaine", says Duhem, "user des mêmes moyens essentiels pour parvenir à la vérité; mais en chaque domaine, il voit cette raison adapter l'usage qu'elle fait de ces moyens à l'objet spécial dont elle veut acquérir la connaissance [...]. Il reconnaît alors que pour aller aux vérités religieuses, la raison humaine n'emploie pas d'autres moyens que ceux dont elle se sert pour atteindre les autres vérités; mais elle les emploie d'une manière différente parce que les principes dont elle part et les conclusions auxquelles elle tend sont différents" (Hélène Pierre-Duhem 1936, 164-165).

⁷ Cf. Stoffel (2001, 79, footnote). Hélène Pierre-Duhem (1936,156), for its part, speaking of his father the Christian points out, in the same sense, that what it is objected to the faith you can also object to the science considered to be the most rigorous and, recalling the charter loss directed by his father to his friend Récamier, quotes the words of the letter to note the impossibility of defining concepts as clear as *corps, âme, Dieu, mort, vie, bien, mal, liberté, devoir*; and, thus, the impossibility of proving propositions so certain as: "Le monde n'a pas en lui-même une raison d'être de son existence. Je dois faire le bien et éviter le mal". The passage quoted from this letter concludes by pointing out that our sciences more certain resting on foundations of the same nature.

notions, these principles, are formed by *le bon sens*. Without this foundation of the *bon sens*, nothing scientific could have some science. (Picard 1921, 41)⁸

Stoffel cites an article of Édouard Jordan, which this issue has been developed, almost in the same terms, and mentions that there is no doubt that Jordan may object to Duhem that the principles of spiritualism or of faith are not justified:

But answered that, in spite the illusions to the contrary, it is the same for all the sciences including those that are taken as the most rigorous, even the geometry. They are based on the notions that we claim to understand, despite not being able to define and that are provided by the *bon sens*. (*apud* Stoffel 1995, 64)

Thus, in its position with respect to the existence or not of an antagonism between science and religion, it is the *bon sens* as a fundamental part of the understanding of Duhem on the procedures of science.

In addition, on the other hand, Martin Hilbert (2000, 6) in his thesis for the degree of Doctor of Philosophy, has pointed out the relationship between the Energetics and the notion of natural classification in the thinking of Duhem. The notion of natural classification was presented by Duhem in his article entitled "L'école anglaise et les théories physiques, à propos d'un livre récent de W. Thomson". This paper attempts to respond the question on why it should prefer a coherent theory rather than a set of inconsistent theories? The answer is that the perfection of a theory depends on a certain degree of approximation to the ideal theory, which is "the total metaphysical explanation and adequate to the nature of material things: this theory, in fact, classifies the physical laws in an order that will be the very expression of metaphysical relations between the essences, which emanate such laws; they give us the natural classification of the laws in the true sense of the word" (Duhem 1987, 136).

On the other hand, in *La théorie physique* Duhem, establishes a close link between the *bon sens* and the notion of natural classification. In chapter II of the first part, he explains that the notion of the physical theory as a symbolic representation of the experimental laws, implies that the logical order and the "artificial ordering" of these laws are manufactured by the theoretical physicist, however he has the "presentiment", to the degree to become a firm conviction, that the order is a reflex of an ontological order, which is a reflex of a "natural classification"⁹. To justify this conviction, the theoretical physicist needs to transcend the methods and procedures of the theoretical physics, he needs to refer to: "an intuition in which Pascal has recognized one of those reasons of the heart 'which reason does not know', he affirms his faith in a real order, which theories are an image clearer and more faithful every" (Duhem 1906, 38-39).¹⁰

Finally, in various places, and particularly in *La science allemande*, Duhem sets out the tasks that the *bon sens* perform within the activities of the science: the common knowledge, common sense, good sense and the spirit of fineness provide the axioms of mathematics and the hypotheses of the physical theory. The first lesson of *La science allemande* entitled "Les sciences de raisonnement" ask about the question of what is the source of the axioms that are the foundation of these sciences? Duhem responds quoting Pascal: "We know the truth, not only by reason, but also by the heart", said Pascal; of the latter is how we know the first principles. The second lesson of this work is entitled "Les sciences expérimentales" and ask about the question how do the experience provide a proper hypothesis to serve as a principle of the experimental science? Duhem responds with an example of the procedure used by Pasteur: who tested a preconceived idea and through "trial and error" modifications are made in accordance with the facts are

⁸ "À force de réfléchir à ces difficultés, je me suis aperçu qu'on en pouvait dire autant de toutes les sciences, de celles qu'on regarde comme les plus rigoureuses, la Physique, la Mécanique, voire la Géométrie. Les fondations de chacun de ces édifices sont formées de notions que l'on a la prétention de comprendre, bien qu'on ne puisse les définir, de principes dont on se tient pour assuré, bien qu'on n'en ait aucune démonstration. Ces notions, ces principes, sont formés par le bon sens. Sans cette base du bon sens, nullement scientifique, aucune science ne pourrait tenir; toute sa solidité vient de là" (Picard, 1921, 41).

⁹ In paragraph X of chapter IV, which is the last of the first part, Duhem points out another trend which is the inseparable companion of the trend toward the natural classification that trend toward the unit.

¹⁰ In the last three sections of "The physics of a believer" Duhem emphasizes the need to transcend the method of theoretical physics, that is, to resort to the method of metaphysics, to justify both the tendency to unity as the tendency to the natural classification by the analogy between the physical theory and cosmology.

directing: "In this work of successive retouch-ups which a first idea, necessarily risky and often false, ends up developing a fruitful hypothesis, the deductive method and intuition play one another their role; but here it is much more complex and more difficult define this role that in a science of reasoning" (Duhem 1915, 27). In this way, notions richer in content, but less accurate and less analyzed than the notions of the science of reasoning are produced for the joint role of deductive and intuition methods: the rules of logic are not effective enough to be able to reason about these notions, they must be supported by "a kind of sense of fairness which is one of the forms of good sense" (Duhem 1915, 28).¹¹

The Philosophical Aspect

First, in the criticism by Abel Rey, not of the physical but of the scientific philosophy of Duhem, he accuses him of doing metaphysics by taking as a starting point a determined notion of human knowledge. In fact, Rey said that Duhem has succumbed to the temptation of metaphysics, having on his head a preconceived idea of the value, of the limits and of the nature of science. Duhem responds, in "The physics of a believer", that his "physical system" by its origins and its consequences is positive. Of this to succumb to the common temptation, Rey may conclude that:¹²

Unless we limit science to nothing but the collection of empirical recipes – and even this pretension, isn't the result conscious of a metaphysical tendency? – at times the metaphysical problems are so close to the great scientific questions; the human spirit is so eager to prolong its curiosity by imagining new whys it is chimerical and abstract to want to put an insurmountable, and above all unsurpassed, gap between science and metaphysics. (Rey 1904, 733)¹³

Does Duhem put an insurmountable gap between science and metaphysics? It does not appear, but it *distinguishes* the science of metaphysics because it discusses their mutual independence and autonomy. But before arguing in favor of the negative answer to this question, let's ask: what is the basis on which the autonomy between science and metaphysics rests? The answer to this question is found in article "Physique et métaphysique" of 1893, which sets forth the following which supports the view of Abel Rey before mentioned: human beings do not have direct knowledge of the essences of the external things, but of the phenomena and of the succession of these phenomena (Duhem 1987, 86). In these lines, a distinction is made between *essence* and *phenomena*.¹⁴ This distinction is the basis for distinguishing between science and metaphysics. The essences are conceived as causes of the phenomena.

The intelligence of man, on the one hand, know directly the phenomena and the laws according which these phenomena are related and, on the other hand, known indirectly something of the essences because the knowledge of the effects allows us to know something about the substances that produce these effects; however, this knowledge is neither complete nor adequate for these substances (Duhem 1987, 86). The distinction between essences and phenomena has led us to the distinction of two types of knowledge: the knowledge that human intelligence has of the phenomena and their laws, on the one hand, and, on the

¹¹ In section X of chapter VI of the second part, section entitled "Le bon sens est juge des hypothèses qui doivent être abandonnées", also shows the reasons why the *bon sens* is the judge on the choice of the hypothesis.

¹² Duhem does not seem to respond to the accusation of Abel Rey on "Mais nous n'avons eu ici que l'intention d'examiner *la philosophie scientifique* de M. Duhem, et *non l'oeuvre scientifique elle-même*" (Rey 1904, 743-744, emphasis added), as its defense goes to show that your "physical system" is positive and does not depend on the metaphysics or religion. However, the assertion of Rey that Duhem makes metaphysics can justify the response of the latter.

¹³ "A moins de borner la science à n'être qu'un recueil de recettes empiriques – et encore cette prétention n'est-elle pas le résultat plus ou moins conscient d'une tendance métaphysique? – les problèmes métaphysiques sont, à certains moments, si près des grandes questions scientifiques, l'esprit humain est si désireux de prolonger sa curiosité, en imaginant toujours de nouveaux pourquoi, qu'il est chimérique et abstrait de vouloir mettre un fossé infranchissable, et surtout infranchi entre la science et la métaphysique" (Rey 1904, 733).

¹⁴ This distinction can lead to interpret the thought of Duhem as a kind of kantism, however, for Kant *things in itself*, the essences are unknowable, while, for Duhem, the essences can at least in part be known by the intelligence of man; at this point he follows the principle of deducting the causes through the phenomena.

other hand, partial knowledge of the essences that are the root causes of the phenomena. The second of these sciences is one that receives the name of metaphysics. The first is the positive science which is divided into various branches depending on the nature of the phenomena being studied.

The distinction between physics and metaphysics carried out by Duhem was severely criticized because, to exclude the causal explanation of the phenomena from the task of the physical theory and reserve this task the field of metaphysics. However, Duhem has emphasized the need to transcend the method of theoretical physics because basically there are two trends: 1) the need to achieve a coherent and unique theory and 2) the need to achieve a natural classification of the laws of physical theory. In other words, the affirmation that a coherent and unique theory is possible and the claim that the classification of the laws of physics theory tends to reflect the ontological order of things, both statements are metaphysical claims that cannot be founded by the procedures of the positive sciences, but that are supported by the good sense. Duhem is aware that these statements are of a metaphysical character as shown in “The physics of a believer”:

Let us indicate what is the present form of physical theory which seems to us to tend towards the ideal form and which is the cosmological doctrine which seems to have a stronger analogy with this theory. We do not intend to give this indication in the name of the positive method proper to the physical sciences. From what we have said, it is clear to the evidence that it exceeds the limits of this method, that this method can neither confirm nor contradict it. In giving the [indication] we know that we have abandoned the domain of physics, thereby penetrating the proper domain of metaphysics, we know that after having toured the latter domain in our company, a physicist may very good refuse to follow us on the proper domain of metaphysics, without violating the rules that logic imposes (Duhem 1914, 463-464).¹⁵

In this way, the Duhemian distinction between physics and metaphysics is not a radical separation as can be understood by Abel Rey and by the interpretations of the thought of Duhem that put emphasis on the apologetic role of this thought. Then, it seems me clearly that, although Duhem carries out a distinction between physics and metaphysics, this does not mean that he can't formulate metaphysical statements or for him the metaphysics is a kind of knowledge¹⁶; and, on the other hand, that there is the possibility of an articulation between the two areas of knowledge.¹⁷

The Historical Aspect

The distinction between physical theory and metaphysical – including religion in this last –, more specifically, the argument about your mutual independence, where the physical theory may not be useful to defend the religion but neither can serve to attack it, seems to correspond with the idea expressed by Ariew and Barker, who affirm: “For most of the nineteenth century, scholars treated ‘medieval science’ as an oxymoron. Since nothing from the middle ages was worthy of the name ‘science’, no history of medieval science could be written” (Ariew and Barker 1992, 324). This does not seem to agree with the idea of a historical continuity of science, as it can be thought that, on one hand, are declared as independent of each other, but on the other hand it is accepted that the initiated mechanical science for Galileo inherited of the Middle Ages its

¹⁵ “[...] il nous sera permis d’indiquer quelle est la forme actuelle de théorie physique qui nous paraît tendre vers la forme idéale, et quelle est la doctrine cosmologique qui nous semble avoir, avec cette théorie, la plus forte analogie. Cette indication, ce n’est pas au nom de la méthode positive propre aux sciences physiques que nous prétendons la donner; après ce que nous avons dit, il est clair jusqu’à l’évidence qu’elle excède la portée de cette méthode, que cette méthode ne peut ni la confirmer, ni la contredire; en la donnant, en pénétrant par là sur le domaine propre de la Métaphysique, nous savons que nous avons délaissé le domaine de la Physique; nous savons qu’un physicien, après avoir, en notre compagnie, parcouru ce dernier domaine, peut fort bien, sans violer les règles que la logique impose, refuser de nous suivre sur le terrain de la Métaphysique” (Duhem 1914, 463-464).

¹⁶ From 1893, in his article “Physique et métaphysique”, Duhem talks about the metaphysics assuming it is a type of knowledge.

¹⁷ Lucas Roumengous (2016) has developed this articulation in his work entitled precisely: “L’articulation entre physique et métaphysique chez Pierre Duhem”.

principles and the formulation of their essential propositions (Duhem 1984, preface, V). This appearance of contradiction can reinforce the idea that in the thinking of Duhem, there is a "crypto-theology of Providence".

In previous pages, it was stated that the distinction between physics and metaphysics is supported on the distinction between phenomena and essences. This last distinction also is the basis of the notion of theoretical physics as symbolic representation of the experimental laws and not as an *explanation* of the causes essential hidden under the phenomena. In addition, the distinction between phenomena and essences is the foundation upon which rests the idea of "save the phenomena", such as the word *phenomena* of this sentence can indicate it; in effect, the value granted by the theorists to the scientific hypotheses have two alternatives: realism or instrumentalism¹⁸ which is developed historically in *Sauver les phénomènes: Essai sur la notion de théorie physique de Platon à Galilée*:

To save the phenomena is perhaps the most controversial of all Duhem's works, and the easiest to misinterpret if not read with sufficient care. In it all the various criticisms of his work seem to come together: excessive positivism; Neo-Scholasticism; apologetic for the Roman authorities. But it cannot without qualification be labelled both neo-scholastic and positivist, or both positivist and Catholic apologetic. (Martin 1991, 163)

If all criticism of the work of Duhem are presented together in *To save the phenomena*, it is because all aspects of this work are displayed together. As has already been pointed out, the notion of science as a symbolic representation (its scientific aspect) and the distinction between physical and metaphysical theory (its metaphysical aspect) and the struggle between realism and instrumentalism throughout history, are based on the distinction between essence and phenomena. All these aspects, as has been shown, seem to lead the Ariadne's thread that guides the work scientific and philosophical and historical of Pierre Duhem: the apology of the ecclesiastical authority.

However, Duhem assigned another task to the history of science. As is well known by all the scholars of the thought of the French physicist, Duhem has exposed in various places such a task to be played by the history of physics in the conception of the physical theory. In 1892, the article "Quelques réflexions au sujet des théories physiques", it is exposed, in paragraph 7, "Le rôle des théories mécaniques dans l'histoire de la science", and it answers the question: "If these theories are based on an idea of the role of physics that is so completely erroneous, how does it come about that they have been able to make such great progress in physics?" The answer to this question is that in the "evolution" of all science mechanical theories correspond to the first stage of the development of the physical theory. We noticed that here it is the role of the mechanical theories in the history of science and not – as in other parts of the work of Duhem – of the importance of the method of the history in physics. The interest of the exposed in this article of Duhem is that already on this date is the idea of "evolution" and the development of the theories of physics and, therefore, of a conception of the history of physics, idea reinforced with the analogy of the development of human intelligence.

Of the above, arises the problem of what is the purpose of the evolution of the theories of physics, whose stage of childhood are the mechanical theories? The answer to this question can be found in *La théorie physique*, chapter III of part one – "Les théories représentatives et l'histoire de la physique" – whose first section is dedicated to explaining the role of the *natural classifications* in the evolution of the physical theories: The purpose of the physical theory is to become a natural classification. To explain the role of these *natural classifications* it asks: If the theory must become a natural classification, whether it should seek a group the phenomena as are grouped the realities, then the most secure method of achieving this goal is not that of search before all what are these realities? (Duhem, 1906, 45-84).

The solution of this questioning is carried out by means of the distinction of two constituent parts of any theory that seeks to explain the phenomena: first a representative part and second an explanatory part. The development of each of these parts is performed independently from one another, your link is "very weak and superficial" and the explanatory part is juxtaposed to the representative part like a parasite. In

¹⁸ From the work of Paul Needham (1998), Brenner (1990), and Stoffel (2002) has deployed the debate on the realism and/or instrumentalism in the thinking of Duhem. More recently, an amount of different types of Duhemian realism has been deployed: the structural realism of Elie Zahar (2000), the motivational realism of Merikangas Karen Darling (2003). Consult the work of Fábio Leite (2017) for this theme.

addition, this independent development of each one of the two parts of the physical theory has a consequence related to the history of physics:

While the progress of experimental physics put the theory in difficulties, while forced to modify it, to transform it, the purely representative enters almost whole in the new theory, gives you the inheritance of everything more valuable than had the old theory; while the explanatory part succumbs to leave their place to another explanation. Thus, for a continuing tradition each physical theory inherits the part of the natural classification that has been able build to that which follows. (Duhem 1906, 48)¹⁹

Thus, according Duhem the role played by the history of science generally and the history of physics particularly is reach the goal of becoming the natural classification, that is, a classification that reflects the ontological order. However, since the belief or conviction in a tendency to the natural classification, has as its foundation on "an intuition in which Pascal has recognized one of those reasons of the heart 'which reason does not know', he affirms his faith in a real order, which theories are an image clearer and more faithful every" (Duhem 1906, 38-39), then the apologetic role of the history of physics is maintained.

In sum, in the three general and principal parts of thought of Pierre Duhem, it keeps the apologetic aspect of such thought. In fact, in all these parts of the thinking of the French philosopher the notion of *bon sens* has a fundamental role and the *bon sens*, in turn, is based on the doctrine of the heart of Pascal, as we hope to show below.

Duhem and Aristotle

Some of his commentators and selfsame Duhem have pointed the Aristotelian background of his thought. Martin has rightly pointed out that in the conclusion of *Le mixte et la combinaison chimique: Essai sur l'évolution d'une idée*, Duhem explained an analogy between your physics and that of Aristotle, and in the "Physics of a believer" is included the section IX entitled: "De l'analogie entre la théorie physique et la cosmologie péripatéticienne". Stoffel in his turn has said that the Duhemian phenomenalism is formulated not only to respond the criticisms and dangers, but that from very early has its roots in an Aristotelian perspective, recognized by Blondel from 1893 by calling to your correspondent: my dear peripatetic (Stoffel 2007, 339).²⁰ Martin has related directly and explicitly the "Aristotelian flavor" of the thought of Duhem with its methodology of the *bons sens*. However, Martin appears to reject the Aristotelian influence on the thinking of the French thinker because it is based on superficial analogies. Probably Martin is right because this influence is not always carried out directly, but through multiple transformations occurred over a long period in the time, as we hope to show with regard the relationship between the notion of *noûs* and *bon sens*.

In chapter IV of its magnificent book about Duhem, Martin relates the Aristotelian *epagôgê* with the problem of the infinite regress,²¹ a problem that arises from the claim that we should not accept any proposition that has not been proven and we should not accept any term that has not been previously defined. The rigorous application of this idea leads, of course, the infinite regress in the demonstrations and in the definitions. According to Martin, Aristotle proposes as a solution the *epagôgê*, which in the Stagirite is

¹⁹ "Lorsque les progrès de la Physique expérimentale mettent la théorie en défaut, lorsqu'ils l'obligent à se modifier, à se transformer, la partie purement représentative entre presque entière dans la théorie nouvelle, lui apportant l'héritage de tout ce que l'ancienne théorie possédait de plus précieux, tandis que la partie explicative tombe pour faire place à une autre explication. Ainsi, par une tradition continue, chaque théorie physique passe à celle qui la suit la part de classification naturelle qu'elle a pu construire..." (Duhem 1906, 48).

²⁰ Stoffel añade: "Duhem poursuivra d'ailleurs dans cette voie aristotélicienne en restaurant les qualités au lieu de s'en tenir aux seules quantités et, une dizaine d'années plus tard, en établissant, d'une manière qui paraîtra peu convaincante, une certaine analogie entre la thermodynamique et la cosmologie du Stagirite" (Stoffel 2007, 340).

²¹ Martin points out that: "Aristotle, almost certainly the originator of both the infinite regress argument and of the formal logic, without which it could hardly have been formulated. [...] Aristotle's answer, *epagôgê*, often translated 'induction', seems to be a kind of intuitive process in which in course of continuous immersion in experience, the principles of science emerges from the contemplation of many instances of its objects" (Martin 1991, 72).

closely linked with the *aisthesis* or sensation. Aristotle's the manner to solve the problem, says Martin, is to be compared with the treatment that gives Leibniz in his letter of April 1686, addressed to his friend skeptical Simon Foucher, where it is concluded that: "Proofs could not go to infinity [...]; but it remains the case that there is no way of proving these principles" (Martin 1991, 73). To finish the chapter IV of his book, Martin points out that Pascal has his special way of dealing with the problem of infinite regress: "It is in the *Pensées* that the full implications of his position emerge, with his doctrine of the heart that has its reasons that reason does not know". This specialist in Duhem's work appoints one of the most well-known fragments of the *Pensées*, and concludes:

However, here, Pascal has other ends in view, an *Apology for the Christian religion* [...]. Reason and sense thus play different *rôles* in different subject-areas, which, [...], are separated from one another, separated by method as they are separated by the subject-matter. Equally, [...], Pascal has separated off faith from physics in just the manner we have seen in Duhem, ruling out equally the use of natural reasoning to defend Christianity and to attack it. (Martin 1991, 75)

Martin has enabled us to establish a close relationship between the methodology of the *bon sens* and the Aristotelian *epagôgê* through the problem of the infinite regress; and between the problem of *infinite regress* and the solution proposed by Pascal to this problem with "his doctrine of the heart". According to Martin, his doctrine leads precisely to the separation, at the same time methodological and thematic, Duhemian and Pascalian, of two areas that do not touch each other: the reason and the senses are two faculties that serve entirely different areas, in such a way that the natural reason may not be useful neither to defend nor to attack the faith. However, let's not forget that to Aristotle, the virtue which allows us to grasp the principles is the *noûs* through the procedure of the *epagôgê* which appears to be the solution proposed by the Greek philosopher the problem of the infinite regress. In sum, it is possible to establish a relationship between the *bon sens* and the *noûs* and "doctrine of the heart". We need to return to the thought of Aristotle to explain this possible relationship.

Aisthesis and *Noûs* in Aristotle

In the sixth book of the *Nicomachean ethics* we find the famous Aristotelian classification of the different kinds of virtues by which the knowledge is acquired: *téchne*, *epistéme*, *phrónesis*, *sophía* and *noûs* (Aristotle 1926, 1139: 15-20). Later, in this work, it is argued that only the *noûs* can capture the principles. Aristotle explains what should be understood by each of these capacities and concludes that the principles can only be captured by the *noûs*, although it is not very clear what the procedure by which the *noûs* captures the principles is. In the *Posterior analytics* Aristotle expresses:

Since we learn either by induction [*epagôgê*] or by demonstration [*apodeixis*]. Now demonstration proceeds from universals and induction from particulars; but it is impossible to gain a view of universals except through induction [*epagôgê*] (since even what we call abstractions can only be grasped by induction [*epagôgê*], because, although they cannot exist in separation, some of them inhere in each class of objects, in so far as each class has a determined nature); and we cannot employ induction if we lack sense-perception, because it is sense-perception that apprehends particulars. It is impossible to gain scientific knowledge of them, since they can neither be apprehended from universals without induction, nor through induction apart from sense-perception [*aistheseos*] (Aristotle 1960, 81 a35-b5).

The widespread and common interpretation of this paragraph is that the described procedures are two: 1) one, take as starting point the universal and through a deductive procedure is inferred a conclusion or conclusions²²; and, 2) another, ask for the origin of the knowledge of universals (*Posterior analytics*, 99b

²² In the *Nicomachean ethics* Aristotle (1926, 1139b 20-35) uses a different terminology. It says here that the whole *episteme* has the ability be *didaktè* (taught) and *matheton* (learned); the teaching can be by *epagôgê* or *sillogismòs*.

15 ss), Aristotle concludes that we must have a *dýnamis*, a faculty that captures the universal (99b 30-35). In the first lesson of *La science allemande*, which is about the "sciences of raisonnement", Duhem (1915, 4-22.) explains the behavior of these sciences, corresponding to the previous Aristotelian explanation and concludes questioning: "Des axiomes, quelle est la source?"

In the final part of the *Posterior analytics* (99b-100a.) seems to be exposed, in some detail what was stated at the beginning of the *Metaphysics* (980a-981b). The first work Aristotle deals with how to acquire the principles, how they become known, and questioned what is your *hexis*. He proposes two alternatives: 1) we possess them (innately) and 2) we acquire them through a procedure. The first alternative is discarded as absurd, since we would have something of which we were unaware and the second alternative is in contradiction with the idea that all knowledge comes from previous knowledge. Without clarifying this contradiction, it is concluded that there must be a *dýnamis* or power which we acquire the principles.

Immediately after, it is stated that there is an innate *dýnamis*, a faculty to distinguish, called *aesthesis*, sensation. There are two ways to put into action this power: 1) with persistence or perseverance and 2) with neither perseverance nor persistence. When this faculty is done without persistence, there is no more knowledge than the sensation selfsame, and when she performed with persistence there is a knowledge besides of the sensation: of the sensation arises the memory and of the repeated many times memory of the same thing arises the experience and of this experience arises the principle of art and science. Aristotle explains that when in the soul some of the entities persists or is still present, then for the first time it is presented in soul the universal; and in the next place, produces a new detention or persistence of the initially achieved universal and so on until the first universals. Aristotle concludes by saying that: evidently we know necessarily by *epagôgè*, since this is how the *aesthesis* produces the universal. Finally, it explains that of all the *hexis*, the habits exposed in the *Nicomachean ethics*, the *episteme* and the *noûs* have a relationship and which the latter is the most accurate of all, since the *archai* (principles) are better known than the knowledge provided by the *apodeixis* (demonstrative procedure) and, therefore, the principles are captured by the *noûs* and that there is nothing more true than this one (*Posterior analytics* 100b 1-15).

In the paragraph immediately above, we shows a close relationship between the *aesthesis* (the sensation) and the *noûs* (faculty that captures the principles): the first is the starting point of the *epagôgè* which is the procedure through occurs the universal in the soul, the universal is another name for the principles; while the second – *the noûs* – is both the *hexis* and *areté* that captures the principles and is the starting point of the demonstrative procedures (*apodeixis*), therefore, too it is the starting point of the *episteme* (science). While the ability to sense – *aisthesis* – is the point of departure of the procedure; the *noûs*, ability of grasp the principles, the noetic catchment, is the point of arrival of procedure by which are provided us the principles of knowledge.

From the *Noûs* to the *Bon Sens*

A manifestation of the syncretism product from the confrontation of the Greek culture with the Alexandrian-Jewish culture was carried out by the task of translation of the sacred texts of Judaism. This translation was commissioned by Eleazar, the Jewish high priest, to 72 Jewish priests, and requested by Ptolemy II Philadelphus. So, this translation is known as the bible of the 70. According to the *Dictionary of theology* of Lothar Coenen and Erich Beyreuther and Hans Bietenhard, the Greek word *noûs* is related to a group of words: *noéo*, *diánoia*, *énnoia*, *nóema*, *anoia*. "If it is compared the central rôle played by the *noûs* in Greek thought, one is surprised by the low use that make the LXX of this group of words. The word appears with a greater relative frequency is *diánoia*, with 75 testimonies; on the contrary, *noûs* and *noéo* have only 35 testimonials each; the other derivatives are scarce even more" (1994 [1971], 10).

According to the authors of this dictionary, "the limited presence of this group of words in the Septuagint is because the Hebrew does not have an equivalent of the Greek [word] *noûs*", which is often translated by the words *Léb* or *lébáb*, which in the version of the Septuagint are used 6 times to translate the Greek word *noûs* and 38 times to translate the Greek word *diánoia* which 'almost always is replaced by *kardia*', "heart". Likewise, in the version of the Septuagint, also it is used [the Greek word] *diánoia* (about

The syllogism part of principles that cannot be tested by syllogism, but by the *epagôgè*. However, it is not very clear procedure in which consists the *epagôgè*.



75 testimonials) to translate the Hebrew word *Léb* or *lébáb*, "heart"; in addition, are also used some twists as: "an honest sense" (4 Mac 1, 2, 16; 35); "a pure sense" (8, 3 TestBen); "good sense" (4, 12). Also in Josephus: a *healthy sense* (Ant. 8, 23); in a very typical manner of Old Testament, the heart is called organ of knowledge (Prov 16, 23; Is 6.10).

According to the *Dictionary of theology* cited earlier, Philo of Alexandria used the Greek words *noûs* and *diánoia*, referring to them as "the divine in the human" (Det. Pot. Ins. 29), "an organ of divine knowledge" (Virt. 57), that which makes man immortal (Op. Mund. 135). In addition, according to Marta Alesso, "Philo says that the soul is composed of the following parts: the 'guideline' (*hegemonikon*) or 'rational' (*logikon*) part which is the same as the intellect (*noûs*) and the part irrational (*alogos*)..." (Alesso 2011, 22). We emphasize that are identified *logos* and *noûs*. The encounter of Greek philosophy and the Jewish religion transformed the *noûs*, both identifying it with the *logos* and transforming it into the *kardia*, the heart. Something similar happens in Christianity, to display it extensively quoted from the *Dictionary of theology*:

If we throw a first glance superficial on the frequency with which the group of words related to *noûs* in the New Testament, confirms the finding that we did in the LXX: neither in the N[ew] T[estament] plays a central rôle. *Noûs* is attested only 24 times; *katanoéo* and *noéo* are 14 times each; the other forms derived are still more rarely. However, this statistical glance provides us a false impression. Certainly, the theme of the *noûs* plays a secondary rôle in the Gospels (with the exception Lc [Lucas], which uses 8 times *katanoéo*) and in the Post-Paulines letters; instead, the type of Hellenistic Greek mentality is found most frequently in Paul (21 of the 24 testimonies of *noûs* belong to the so-called *corpus paulinum*). The noun *noûs*, which appears in Paul and the writings of the Post-Paulines (Eph, Col. and pastorals) means *mind* in terms of *discernment*, *the ability to judge*, *ability to discern* (e.g. 2 Thess 2, 2). But this discernment is the religious insight, the ability to judge religious, which is situated next to the consciousness (Tit 1.15). Thus, *noûs* occupies a place parallel to the faith, which in the Pastoral Letters comes to mean "religion"; in Rom 7, 23 Paul writes: "In my body I perceive different criteria that is waring against the criteria of my *noûs*". Later, in verse 25 it is said: "On the one hand, with my *noûs* (is to say: I as *noûs*) I am subject to the law of God; on the other, with my instincts (that is to say: I as meat) I am the law of sin". This *noûs* is the same as the *éssó ánthrópos*, the inner man (that is: inner man, in the most intimate, in his own interiority; cf. Rom 7.22; Eph 3.16) or the *egó* (Rom 7, 9.10.14.17.20.24.25), the authentic self, that can discern between good and evil. The ego recognizes that the law is good; the ego wants to comply with the law, but the law recognized by the *noûs*, law of religious insight, contradicts the other law of sin. Therefore, here *noûs* is the knowledge and understanding religious, who recognize and honor the law of God. Those appointments where *diánoia* is in *parallelismus membrorum* with *kardia*, *heart* show it like this. (Heb 8.10; 10.16; of the LXX Jer 38, 33) (Coenen, Beyreuther and Bietenhard 1994 [1971], 12-13)

The meeting of Greek thought with Judeo-Christian thought has transmitted to us the Greek word *noûs* through the notion of *kardia*, *heart*, both words with the meaning of "the capacity of capture first principles". The predominance of the Jewish-Christian thought on the pagan Greek thought, derived from his meeting, obliterated the Greek concept of the word *noûs* and privilege the Jewish-Christian notion of the word *heart* or from the Greek word *kardia* thought-out of Jewish-Christian way. This predominance of the Jewish-Christian thought can be displayed even we review one of the foundations of the Reform movement. According to Richard Popkin (1989), in fact, one of the fundamental principles of the reform of Luther is his questioning of the authority of the criteria of Pope and councils for accepting the truth of the scriptures. If Luther rejects the authority of the Pope and councils as a criterion of truth of the Bible, then what is the criterion that the reformer accepts to determine the truth of the Scriptures? The answer is to be found in various places in the work of Luther, let us mention two, the first of the *Discourse at the diet of worms* in 1521, and the second, at the *De servo arbitrio* of 1525:

Since your distinguished majesty and your lordship demand me a response, I will give it unabashedly: Unless I am convinced by the testimony of Scripture or for obvious reasons – because I do not believe in the Pope nor in the Councils alone, since clearly they were wrong and have often contradicted themselves – I am chained by the scriptural texts that I have quoted and my *conscience* is captive to

the Word of God. I cannot and do not want to recant in nothing, because it is neither safe nor honest to act against self-awareness. That God help me. Amen (Luther, 2006, 175, emphasis mine).

In *De servo arbitrio*:

But, as I said before, I will not openly express myself. In the meantime, I excuse your *very good intention of heart*; but do you go no further; fear of the Spirit of God, who searches the reins and the heart, and who is not deceived by artfully contrived expressions. I have, upon this occasion, expressed myself thus, that henceforth you may cease to accuse our cause of pertinacity or obstinacy. For, by so doing, you only evince that you hug in your heart to Lucian, or some other of the swinish tribe of the Epicureans; who, because he [Epicuro] does not believe there is a God himself, secretly laughs at all those who do believe and confess it. Allow us to be assertors, and to study and delight in assertions: and do you favor your Sceptics and Academics until Christ shall have called you also. The Holy Spirit is not a Skeptic, nor are what he has written on our *hearts* doubts or opinions, but assertions more certain, and more firm, than life itself and all human experience (Luther 1931, 9, emphasis mine).

It seems, then, that the “doctrine of the heart” of Pascal can be traced back to the doctrine of the Greek *noûs*, but mediated by the Jewish-Christian tradition and transformed by a series of attempts to reconcile this with him. In this sense, it is possible to speak, as Duhem speaks about *the natural classification*, of a tradition of thought which is inherited along the passage of time, but that does not pass in the same way from generation to generation, but amending and fused with other forms of thought. As well, seems that the Greek *noûs* was inherited and transformed into the notion of “heart” of the Jewish-Christian and the Jewish-Christian notion of “heart” was inherited and transformed into the Duhemian *bon sens*.

Epilogue

According to Stoffel, in the analysis of the task apologetic of the thought of Duhem, we must set the following distinction: there are explicit and implicit tasks. According with this specialist of the thought of Duhem, the apologetic task of the work of French physicist is of second type, an implicit task; that is to say, what motivates Duhem to develop its special conception of the physical theory is not the apology of the religion, but there are in this work an apology of the religion (Stoffel 1995). However, it seems that it is not possible to deny the existence of an apologetic task in the scientific and philosophical and historical work of Pierre Duhem. This inability to deny the apologetic task in the thought of the French physicist is sufficient to establish the possibility of qualifying his thought as or a “crypto-theology of Providence” or as having a hidden agenda.

The opposition between the scientific and apologetic reasons or motives of a system of thought, can also be derived from the perspective which there is such opposition in the science and religion’s very nature. This perspective part of determined notions of science and religion which allow us to set the opposition. Duhem seems to have been aware that the opposition between science and religion is based on these determined notions of both human aspects and, precisely, one of its objectives is to combat such notions of science and religion which establish an opposition between them. Instead, it proposes notions of science and religion that allow its integration. Duhem does not renounce – as positivism – neither the existence of a link between science and metaphysics nor cancels – like positivism – the cognitive reaches of metaphysics.

According to Duhem, science and metaphysics use the same methods and take the same starting point. But neither apply in the same way such methods nor did they take the same way such starting point. They apply the methods in accordance with the specific subject-matter of study of each discipline and the point of departure is taken according to each type of thought. In this way, the *sens commun* can be the starting point of the principles of the *sciences of raisonnement* and the *bon sens* can be the starting point for the hypothesis of the *experimental sciences* and the *esprit de finesse* can be the starting point of philosophy, of religion and of the articulation between science and metaphysics. For this reason, the spirit of fineness, in its different forms, play a role of paramount importance in the system of thought full of the multifaceted thinker of Bordeaux. *Bon sens* that comes from a tradition that goes back to the Greek *noûs*

notion and arrives to our days.

References

- Alesso, Marta. 2011. Qué son las potencias del alma en los textos de Filón. *Circe* 15 (2): 11-26.
http://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S1851-17242011000200001. Consulted June 13, 2017.
- Ariew, Roger and Peter Barker. 1992. Duhem and continuity in the history of science. *Revue internationale de philosophie* 46 (182): 323-343.
- Aristotle. 1926. *Nicomachean ethics*. Translated by H. Rackham. Loeb Classical Library 73. Cambridge: Harvard University Press.
- Aristotle. 1960. *Posterior analytics, Topica*. Translated by Hugh Trendennik, E. S. Foster. Loeb Classical Library 391. Cambridge: Harvard University Press.
- Boeri, Marcelo. 2007. *Apariencia y realidad en el pensamiento griego: Investigaciones sobre aspectos epistemológicos, éticos y de teoría de la acción en algunas teorías de la antigüedad*. Buenos Aires: Ediciones Colihue.
- Brenner, Anastasios. 1990. *Duhem: Science réalité et apparence*. Paris: Librairie Philosophique J. Vrin.
- Coenen Lothar, Eric Beyreuther and Hans Bietenhard. 1994 [1971]. *Diccionario teológico del Nuevo Testamento*, vol. 4. Translated by Manuel Balasch, Miguel A. Carrasco, Domiciano Fernández, Francisco Gómez, Jesús Martín, Faustino Martínez Goñi, Emilio Saura, Severiano Talavero and Alfonso C. Vevia. Salamanca: Ediciones Sígueme.
- Darling, Karen Merikangas. 2003. Motivational realism: The natural classification for Pierre Duhem. *Philosophy of science* 70 (5): 1125-1136.
- Duhem, Pierre. 1984 [1913]. *Études sur Léonard de Vinci: Les précurseurs parisiens de Galilée*. Troisième série. Paris: Éditions des Archives Contemporaines.
- Duhem, Pierre. 1915. *La science allemande*. Paris: Librairie Scientifique A. Hermann et Fils.
- Duhem, Pierre. 1906. *La théorie physique, son objet et sa structure*. Paris: Chrvallier et Rivière.
- Duhem, Pierre. 1914 [1906]. *La théorie physique, son objet et sa structure*. Deuxième édition revue et augmentée. Paris: Marcel Rivière et C^e Éditeurs.
- Duhem, Pierre. 1987. *Prémices philosophiques*. Edited by Stanley L. Jaki. Leiden: E. J. Brill.
- Hilbert, Martin. 2000. *Pierre Duhem and neo-Thomist interpretations of physical science*. Ottawa: National Library of Canada.
- Leite, Fábio Rodrigo. 2017. Quelques notes sur le prétendu réalisme structurel attribué à Pierre Duhem. In *Pierre Duhem, cent ans plus tard (1916-2016)*. Edited by Jean-François Stoffel, with the collaboration of Souad Ben Ali. Tunis: Université de Tunis, pp. 123-164.
- Lutero, Martin. 1931. *De servo arbitrio*. Translated by Henry Cole.
https://www.monergism.com/thethreshold/sdg/pdf/luther_arbitrio.pdf. Consulted June 13, 2017.
- Lutero, Martin. 2006. *Obras*. Edited by Teófanos Egido. Salamanca: Ediciones Sígueme, 2006.
- Martin, Russell N. D. 1991. *Philosophy and history in the work of a believing physicist*. Illinois: Open Court Publishing Company.
- Needham, Paul. 1998. Duhem's physicalism. *Studies in history and philosophy of science* 29 (1): 33-62.
- Pascal, Blaise. 1962. *Pensées*. Texte établi et annoté par Jacques Chavalier. Paris: Éditions Gallimard.
- Picard, Émile. 1921. *La vie et l'oeuvre de Pierre Duhem*. Notice lue dans la séance publique annuelle du 12 décembre 1921 de l'Académie des sciences. Paris: Gauthier-Villars.
- Pierre-Duhem, Hélène. 1936. *Un savant français: Pierre Duhem*. Paris: Librairie Plon.
- Popkin, Richard. 1989 [1979]. *La historia del escepticismo de Erasmo hasta Spinoza*. Translated by Juan José Utrilla. México: Fondo de Cultura Económica.
- Puech, Michel. 1996. L'histoire des sciences selon Duhem, une crypto-théologie de la Providence. *Raison présente* 119: 59-86.
- Rey, Abel. 1904. La philosophie scientifique de M. Duhem. *Revue de métaphysique et de morale* 12: 699-744.
- Roumengous, Lucas. 2016. L'articulation entre physique et métaphysique chez Pierre Duhem.

- https://www.academia.edu/27104125/LArticulation_entre_Physique_et_M%C3%A9taphysique_chez_Pierre_Duhem. Consulted June 13, 2017.
- Stoffel, Jean-François. 1993. Blaise Pascal dans l'œuvre de Pierre Duhem. In *Nouvelles tendances en histoire et philosophie des sciences*. Edited by Robert Halleux and Anne-Catherine Bernès. Bruxelles: Palais des Académies, pp. 53-81.
- Stoffel, Jean-François. 1995. L'histoire des théories physiques dans l'oeuvre de Pierre Duhem. *Sciences et techniques en perspective* 31: 49-85.
- Stoffel, Jean-François. 2002. *Le phénoménalisme problématique de Pierre Duhem*. Bruxelles: Académie Royale de Belgique.
- Stoffel, Jean-François. 2007. Pierre Duhem: Un savant-philosophe dans le sillage de Blaise Pascal. *Revista portuguesa de filosofia* 63: 275-307.
- Zahar, Elie. 2000. *Essai d'épistémologie réaliste*. Paris: Vrin.