Motivational Realism: The Natural Classification for Pierre Duhem

Karen Merikangas Darling†‡

This paper addresses a central interpretive problem in understanding Pierre Duhem's philosophy of science. The problem arises because there is textual support for both realist and antirealist readings of his work. I argue that his realist and antirealist claims are different. For Duhem, scientific reasoning leads straight to antirealism. But intuition (reasons of the heart) motivates, without justifying, a kind of realism. I develop this idea to suggest a motivational realist interpretation of Duhem's philosophy.

1. Introduction. In this article I advance a motivational realist interpretation of Pierre Duhem's philosophy of science. I divide my analysis into three sections. First, I describe the interpretive problem and briefly explain how others have tried to classify Duhem's *The Aim and Structure of Physical Theory* (1914) and *To Save the Phenomena* (1908). Next, I present my own proposal and demonstrate how it adapts and improves on previous accounts. Lastly, I offer some concluding remarks.

2. The Problem. How ought we to classify Duhem's philosophy of science? This question has long plagued philosophers and historians of science, but using broad strokes we can fairly easily characterize the most recent attempts at an answer. Our story begins with Karl Popper, who, in *The Logic of Scientific Discovery* (1959) and *Conjectures and Refutations* (1963), attributed to Duhem an antirealist view of physical theory. In the former work he grouped Duhem with Poincaré and called them the "chief representatives" of conventionalism (1959, 78 n. 1). In the latter, he classified the two of them (and Mach and Berkeley) more generally as "instru-

†To contact the author, please write to: Ethics, University of Chicago, Swift Hall 007, 1025 E. 58th Street, Chicago, IL 60637; e-mail: darling@uchicago.edu.

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mentalist philosophers of science" (1963, 104). Popper's remarks and the availability, since 1954, of an English translation of *Aim and Structure* helped to generate a literature devoted to situating Duhem in the context of the more general realism or antirealism discussion in contemporary philosophy of science. Moreover, with the subsequent translation of *To Save the Phenomena* in 1969, a particular approach became pervasive. Historians and philosophers of science alike addressed the issue and punctuated their analyses with close readings of the relevant texts. Early on, these scholars tended to argue primarily against Popper's purely instrumentalist reading of Duhem (Joy 1975, Giedyman 1976, and Martin 1987). As the 1990 *Synthese* volume reveals, by 1989 most Duhem scholars were squarely in the middle. They classified Duhem's views on science as a "qualified" or "mitigated" instrumentalism, or a "semantic," a "commonsense," or a "convergent" realism. And if Paul Needham's work is any indication, today the pendulum is swinging even farther away from the antirealist reading with which we began (Needham 1991, 1998, and 2000).

Nevertheless, Popper's way of classifying Duhem as an antirealist—in particular, as an instrumentalist and a conventionalist—still commands attention. As recently as 2000 this view was described as "widespread" (Needham 2000, 130). One reason for its popularity is that it appears to have strong textual support. However, the same seems to be true for a realist reading. Hence there is an interpretive problem.

In what follows I discuss both particular passages from Duhem's texts and some of his general philosophical arguments as well as the realist and antirealist conclusions that others have drawn from them. My intention is to highlight what realist or antirealist theses they seem to support or deny, and in that way to present the realist and antirealist interpretations of his work. I begin with the latter.

2.1. The Antirealist Interpretation. Duhem is described as an antirealist based on, for instance, his definition of physical theory (1914, 19). In his view, physical theories function not as explanations but as instruments, by economically representing and classifying laws. It is clear why this description could be taken to recommend antirealism and in particular instrumentalism: if physical theories themselves are mere instruments, we have no reason to suppose that the objects featured in them are real or that their classifications reflect reality. Furthermore, by disavowing explanation as the aim of physical theory, Duhem seems to deny that physical theories are true or even approximately so. He announces this more clearly later when he writes that "a law of physics is, properly speaking, neither true nor false but approximate" (1914, 168). If we were to call a physical theory true, Duhem explains, we could only mean that it agrees

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with experiment and not with the way the world is necessarily (1914, 20–21).

Duhem, then, rejects the idea that physical theories are true (or false) depictions of reality. Instead, he permits only a limited notion of truth, namely, agreement with experiment. And by conferring on physical theory the status of an instrument and not an explanation, he casts doubt on the reality of the objects of scientific knowledge and physical theory's classification of them. These considerations seem to support two antirealist theses. First, the latter appears to be in line with the idea that the objects of scientific knowledge (e.g., atoms) are not real or do not exist independently of scientists and, second, the former appears to deny something the realist holds, namely, that the theories that feature these objects are true or at least approximately so.

What is more, there are passages similar to these in *To Save the Phenomena*. For example, in that later work Duhem concludes that "despite Kepler and Galileo, we believe today, with Osiander and Bellarmino, that the hypotheses of physics are mere mathematical contrivances devised for the purpose of saving the phenomena" (1908, 117). He argues that scientists are unable to establish the truth of the Copernican system conclusively because it and the Ptolemaic system are not contradictory (1908, 109–110). If they were, then it would be impossible for both to be true or both to be false, and that would entail that the falsity of one would establish the truth of the other. Furthermore, he argues that successfully saving the phenomena does not guarantee the truth of a theory. The reason he gives for this is that a proof has not been provided to show that no other astronomical system could possibly save the phenomena as well as the Copernican. Taken together, these two arguments are intended to demonstrate that Galileo's method of crucial experiment—in which "experience, by convicting one system of error, confers certainty on its opposite" (1908, 109)—is itself erroneous. Duhem is well known for his critique of crucial experiment and, more generally, of verification and falsification. Together these critiques compose his underdetermination argument.

The Duhemian underdetermination argument, as advanced in *Aim and Structure,* intends to show that evidence is, strictly speaking, incapable of dictating theory or hypothesis choice (Darling 2002b). This argument is often cited in current discussions of realism and antirealism. Antirealists, in particular, often appeal to it because if neither verification nor falsification is sufficient to determine theory or hypothesis choice, then (presumably) pragmatic or other concerns enter into the scientific community's decision of which theory or hypothesis to accept. If this is the case, then it seems to suggest that, properly understood, scientific theories are not candidates for true depictions of the way the world is; rather, they are at best one empirically adequate choice.

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2.2. The Realist Interpretation. Thus far there appears to be significant textual support for an antirealist reading of Duhem's philosophy. I will now summarize the case for a realist reading. First, the principal reason for interpreting Duhem as a realist turns on his concept of "natural classification." Because it is "to establish among diverse experimental laws a logical coordination serving as a sort of image and reflection of the true order according to which the realities escaping us are organized," his belief in it and the role he gives to it in his work suggests that he is not a full-fledged antirealist (1914, 31). Stathis Psillos, for example, argues that how Duhem conceives of the idea of natural classification specifically supports a structural realist interpretation (Psillos 1999, 38). Duhem's belief in natural classification is a belief that physical theory is tending toward a classification of experimental laws that reflects and orders the realities underlying the phenomena. That is to say, "physical theory is not merely an artificial system, suitable today and useless tomorrow, but . . . an increasingly more natural classification and an increasingly clearer reflection of realities which experimental method cannot contemplate directly" (1914, 270). According to Duhem, this belief in natural classification motivates the work of the physicist and, moreover, entails that the physicist takes physical theory to be at least approximately true.

Because it guides scientific practice, the conviction that physical theory is approaching a natural classification plays a significant role in Duhem's view of science. I will discuss his claim for its motivational power in more detail later. In short, he explains that physicists are "compelled" to see this conviction as the raison d'être of physical theory because if they think that physics merely classifies information and functions as an instrument, then its importance is too "meager."[1] Given this, it could be argued that the idea of natural classification should not be ignored or treated as a sideline to his main antirealist program.

Support for Duhem's claim that the physicist takes physical theory to be true can be found, for instance, in "The Value of Physical Theory." There Duhem maintains that physicists agree with the following claim: "Physical theory confers on us a certain knowledge of the external world which is irreducible to merely empirical knowledge." Specifically, he takes it that they surmise (a) that physical theory "is or tends to be a *natural classification*" and (b) that "it corresponds to a certain supremely eminent order" (1914, 334–335). Furthermore, "knowledge" is to be understood as having a value beyond merely practical utility (such as would be affirmed by a pragmatist). Therefore, the conviction that physical theory approximates a natural classification is at once the belief that it approximates a

1. See 1914, 334–335. See also p. 92 where Duhem asks, "How could those concerned with the useful and not the true be expected to submit themselves to this rigorous discipline [of abstract physics]?"

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true classification. This seems to be in line with the realist's thought that physical theories are, at least approximately, true. What is more, it suggests another realist thesis, which is that the objects of scientific knowledge (i.e., what is classified) are real and exist independently of us.

There is another reason to suspect that Duhem is not the antirealist some take him to be: he criticizes instrumentalist aspects of the conventionalism, positivism, and pragmatism of his day. I regret it is beyond the scope of this essay to go into detail on this point. Please see my account in Darling 2002a for more.

The results of this section can now be briefly summarized. Duhem could be interpreted as a realist because (a) he grants an important role to the conviction that natural, and hence true, classifications will compose an ideal physical theory at the end point of scientific investigation; and (b) in many ways he positions himself in opposition to conventionalism, positivism, and pragmatism. Alternatively, Duhem could be read as an antirealist because (c) he rejects explanation as the aim of physical theory and instead favors as its aim the economical representation of experimental laws; and (d) he seems to deny, through his underdetermination argument and in other passages, that physical theories are true depictions of reality.

What we are left with, then, is an interpretive problem. *How ought we to classify Duhem's philosophy of science?* I will answer this question in the next section.

3. A New Proposal. The purpose of this section is twofold. I aim (1) to advance my proposal that Duhem's philosophy of science should be classified as endorsing motivational realism; and (2) to demonstrate how my approach differs from and improves on earlier attempts to classify his work.

In what follows I argue that Duhem identifies in physicists two intuitions that he believes compel them to adopt a realist attitude. According to Duhem, we simply cannot help but think that physical theory is a reflection of a real and logically unified ontological order. Additionally, I aim to show that he did not mean for the convictions that characterize this realist attitude to constitute a realist program. Duhem rejects scientific realism as such because logically and scientifically it cannot be justified. Lastly, I will argue that the only value he affords this realist attitude is motivational, namely, it imparts significance to scientific practice.

3.1. An Intuition That Physical Theory Tends to be a Natural Classification. There are several passages in *Aim and Structure* in which Duhem describes the conviction that physical theory's classification of experimental laws is natural and not artificial. It is important that we look closely at the language he uses. The following is a representative excerpt:

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> The neat way in which each experimental law finds its place in the classification created by the physicist and the brilliant clarity imparted to this group of laws so perfectly ordered persuade us in an overwhelming manner that such a classification is not purely artificial, that such an order does not result from a purely arbitrary grouping imposed on laws by an ingenious organizer. Without being able to explain our conviction, but also without being able to get rid of it, we see in the exact ordering of this system the mark by which a natural classification is recognized. Without claiming to explain the reality hiding under the phenomena whose laws we group, we feel (*nous sentons*) that the groupings established by our theory correspond to real affinities among the things themselves. (1914, 25–26)

There are three features of Duhem's prose to note in this passage. First, he remarks that the order and clarity of the laws classified by physical theory *persuade* us (*nous persuadent*) that the classification is natural.[2] When we are persuaded we are moved to a belief, position, or course of action, but this need not be the result of a valid argument or a rational demonstration. We could be moved by entreaty or expostulation. Thus, when Duhem uses "persuade" he deliberately holds back from making the stronger claim that the laws' order and clarity demonstrate that the physicist's classification is natural. This becomes clearer later on when he argues that "the physicist cannot take account of this conviction" because the physicist's method, which is restricted to observational data, "cannot prove that the order established among experimental laws reflects an order transcending experience" (1914, 27).

Second, Duhem insists that even though we cannot explain or take account of our realist conviction, we cannot rid ourselves of it. In the same vein he writes elsewhere, "But while the physicist is powerless to justify this conviction, he is nonetheless powerless to rid his reason of it." To explain what he means by this, Duhem adds that we cannot compel ourselves to think the opposite (i.e., that the classification is artificial). In other words, he says, "it is impossible for us to believe that this order and this organization are not the reflected image of a real order and organization." Moreover, in his view, the more complete physical theory becomes "the more we feel that theory tends to be a natural classification" (1914, 26–27).[3] In these ways, I take it, he claims that we cannot rid ourselves of a realist conviction.

2. A similar mention of persuasion is made on p. 24.

3. In the original, the passage from which this line is extracted contains *nous pressentons, nous soupçonnons,* and *nous devinons*. Notice that these words carry an intuitive and subjective sense.

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The third feature I want to emphasize from these passages is the use of expressions that have the sense of arriving at our belief in natural classification by means of feelings, hunches, or intuitions—reasons of the heart (see n. 3). According to Duhem, we *feel* (*nous sentons*) that physical theory tends to exhibit a natural classification corresponding to the way the reality behind the phenomena is organized. Furthermore, he outlines factors that might strengthen our feeling that this is so. We saw one factor above, namely, because we witness physical theory becoming more perfect and complete. Another factor that strengthens our realist feelings is when an experiment confirms the predictions derived from theory (1914, 28, 297–298). In either case what drives our conviction about a natural classification are feelings neither grounded by argument nor able to ground an argument in support of realism.

Specifically, Duhem argues that the conviction these feelings inspire can be neither established nor refuted scientifically. For example, with respect to the assertion that physical theory is becoming increasingly similar to a natural classification, he contends: "Physical method is powerless to prove this assertion is warranted" (1914, 298). Also, he argues, the physicist's belief in natural classification is "as incapable of being justified by this analysis [of the methods by which physical theories are constructed] as of being frustrated by it" (1914, 27). Duhem's argument is empiricist in nature. As I mentioned above, he reasons that the scientific method can concern itself with only observable data and, therefore, cannot judge whether a classification mirrors an unobservable (noumenal) realm.

Duhem's position—namely, that the physicist's realist conviction or feeling cannot be explored scientifically—is also evidenced in his characterization of it as an "intuition" (*une intuition*) and an "act of faith" (*un acte de foi*).[4] One might think that performing an act of faith is a choice. According to Duhem, however, this particular one is not. Recall physicists are powerless to rid themselves of its substance. Duhem draws heavily on Pascal for this portrayal. In fact, he characterized the realist conviction as "one of those reasons of the heart 'that reason does not know'" (1914, 27, quoting Pascal). Duhem is also fond of Pascal's saying, "We have an impotence to prove, which cannot be conquered by any dogmatism; we have an idea of truth which cannot be conquered by any Pyrrhonian skepticism."[5] In short, Duhem identifies in physicists an intuition that physical theory tends to be a natural classification and argues that it can neither be defined nor accounted for scientifically.

4. See, for example, 1914, 27, where he employs both of these terms.

5. Duhem employs this expression on at least pp. 27, 270, and 335.

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3.2. An Intuition That Physical Theory Should Be Logically Coordinated. Duhem detects a second intuition, namely, the unity of science, and makes a similar case for it. He does so by investigating what the source could be for the condemnation of logical incoherence and contradiction in physical theory. He concludes that "neither the principle of contradiction nor the law of the economy of thought permits us to prove in an irrefutable manner that a physical theory should be logically coordinated." What, then, could be the source of our belief in favor of theoretical unity? Duhem's explicit mention of the intuition or feeling that physical theory should be logically coordinated is made in response to this question. He replies: "This opinion [that physical theory should be logically coordinated] is a legitimate one because it results from an innate feeling of ours which we cannot justify by purely logical considerations but which we cannot stifle completely either" (1914, 102). Two things are apparent from this quotation: Duhem takes this feeling to be (1) unavoidable and (2) unaccounted for logically.[6]

He goes on to argue for a third conclusion, namely, that this feeling is innate in every physicist. Read the preface to Maxwell's *Treatise on Electricity and Magnetism,* he declares, and you will see that even those physicists who have developed incoherent theories with contradictory models have done so only with regret. "Every physicist," Duhem argues, "naturally aspires to the unity of science." What is more, he avows "all those who are capable of reflecting and of taking cognizance of their own thoughts feel within themselves an aspiration, impossible to stifle, toward the logical unity of physical theory" (1914, 103). He articulates this sentiment again in "Physics of a Believer" (1914, 294–295). Furthermore, Duhem argues that this aspiration is as old as science itself. History, he thinks, shows us that the transformations physical theory has undergone exhibit a continuous development toward a more perfectly logical theory. Like logic this does not justify the aspiration, although it is a consideration that might urge the physicist to assert it (1914, 296–297).

3.3. The Intuitions' Motivational Role. I shall now argue that, according to Duhem, the intuition that physical theory is or tends to be a natural classification and the intuition that physical theory should be logically coordinated function together to motivate the physicist.

Before examining the role these intuitions play, I will briefly summarize my argument thus far. To advance my new proposal, I have identified two principal features of Duhem's philosophy of science. First, the two intuitions I have discussed in some detail disclose a realist attitude. They both persuade us to attribute features to realities behind the phenomena and

6. See also 1914, 296, where he terms this feeling an "irresistible aspiration," and pp. 294–295, where he reiterates that logic cannot provide support for it.

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urge us to believe in physical theory's ability to reflect them. Second, I hope to have shown that these intuitions do not entail a global realist program or even a specific set of beliefs about the way the world is. As I have repeatedly stressed, Duhem argues that these intuitions are innate feelings for whose content an account cannot be given. The beliefs they stir up can be neither verified nor falsified. In other words, science and logic are both incapable of establishing their legitimacy. And without such legitimacy, I take it, they are unable to ground any prorealist arguments or provide proof for any specific realist claims.

"And yet," Duhem persists, "this feeling surges within us with indomitable strength; whoever would see in this nothing more than a snare and a delusion cannot be reduced to silence by the principle of contradiction; but he would be excommunicated by common sense" (1914, 104). So, common sense would excommunicate—note the religious imagery—anyone who would deny value to these realist feelings. What significance can we suppose them to have, then? To lay out the third principal feature of his approach to science, I shall now argue that, on his view, these realist feelings play a motivational role for the physicist.

Duhem contends "*The study of the method of physics is powerless to disclose to the physicist the reason leading him to construct a physical theory*" (1914, 334). The physicist, according to Duhem, learns from this study that physical theory is a tool. It is an instrument used to order experimental laws, and "the systematic classification that theory gives them does not add or take away anything concerning their truth, their certainty, or their objective scope" (1914, 285). In other words, only experimental laws, which express empirical facts, are true or false and, consequently, only they are obliged by the law of contradiction to be logically coordinated. Classically instrumentalist conclusions, then, seem to Duhem to follow from a critical examination of physical science. Theory, for example, is thought not to be true or false of the world; rather, it is considered either convenient or inconvenient. Additionally, as we saw him argue above, it is not obliged by logic to reject illogicality. Given these conclusions, Duhem claims the physicist "would stop devoting his time and efforts to a work of such meager importance" (1914, 333–334). What, therefore, motivates the physicist to persevere?

Simply put, Duhem thinks that the activity of science is guided by the two realist intuitions I have discussed, along with the related idea that "physical theory confers on us a certain knowledge of the external world which is irreducible to merely empirical knowledge" (1914, 334).[7] "In a

7. Later Duhem describes the type of knowledge referred to here as "purely analogical" and he says it "appears to us as the terminus of theoretical progress, as the limit which theory endlessly approaches without ever reaching it" (1913, 237–238).

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word," Duhem explains, "the physicist is compelled to recognize that *it would be unreasonable to work for the progress of physical theory if this theory were not the increasingly better defined and more precise reflection of a metaphysics; the belief in an order transcending physics is the sole justification* (raison d'être)[8] *of physical theory*" (1914, 334–335). My claim is that this argument demonstrates that Duhem granted a motivational role to the realist attitude he found in himself and others.

Additional evidence for his attributing this role to the realist attitude can be found early on in *Aim and Structure*. At the start of chapter 3 Duhem proposes that the aim of physical theory is to establish a natural classification. Effectively, this realist-sounding aim provides a motive for theory construction in science.

3.4. Putting the Pieces Together. The pieces are now on the table: we have seen how Duhem identifies in the physicist two realist intuitions that, as reasons of the heart, are unable to ground a prorealist argument, although they do, he claims, provide motivation for the practice of science. In view of that, we can answer the question with which I began—namely, how ought we to classify Duhem's philosophy of science? My claim is that motivational realism is the natural resolution that fits all the pieces together.

Arthur Fine coined the term "motivational realism" to classify Einstein's thought. As he defines it, motivational realism has three principal features.

> It is a realist attitude.
> It motivates and gives meaning to scientific activity.
> It does not espouse a global doctrine or a specific set of beliefs about reality.

Quoting Einstein, Fine compares the realist attitude of item 1 with religious feeling (1996, 109–110). He recounts that in correspondence Einstein wrote: "I have no better expression than the term 'religious' for this trust in the rational character of reality and in its being accessible, at least to some extent, to human reason" (quoted in Fine 1996, 110). Einstein also mentions this "trust" in his "Autobiographical Notes" when he writes about his feeling that "out yonder there was this huge world, which exists independently of us human beings and which stands before us like a great, eternal riddle, at least partially accessible to our inspection and thinking" (1996, 110).

8. Roger Ariew and Peter Barker (see Duhem 1913, 237) translate *raison d'être* here as "reason for the existence of," which seems better than "justification" in matching Duhem's intent, since his concern here is not with the epistemological problem of justifying our beliefs.

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According to Fine, this realist feeling encouraged Einstein to pursue science (item 2). The motivational aspect of Einstein's realist language is apparent in the second quotation above, when he depicts the independently existing world like a riddle asking to be solved. Note, however, that it is not a cognitive appeal. Motivational realism does not entail a realist program (item 3). As Fine explains, again quoting Einstein, it "drives the scientific effort with 'no deliberate intention or program, but *straight from the heart*'" (1996, 109; emphasis mine). In other words, "realism is the main motive that lies behind creative scientific work and makes it worth doing" but "it is not as though we were first persuaded that realist theories are somehow best and then, on that account, rationally enjoined to pursue them" (Fine 1996, 110).

The realist attitude and the language that accompanies it exhibit a fact about scientific life for which both Einstein and Duhem believed an account must be given. Fine characterizes Einstein's realist language as "the dues that Einstein felt worth paying for his passionate commitment to science, and for the meaning that scientific work gave to his life" (1996, 111). And I have argued that for Duhem a realist attitude is a natural form of belief for us, which inspires the practice of science but does not entail an endorsement of scientific realism.

In this section I hope to have shown that Duhem's philosophy of science ought to be classified as exhibiting motivational realism. My proposal is an advance over previous accounts because I do not try to see to which side—realist or antirealist—his philosophy tips the scale. Instead, my proposal examines Duhem's realist and antirealist claims to determine what sorts of claims they are. I argue that the former are convictions two realist intuitions induce us to hold, while the latter are conclusions that result from a critical analysis of science. The analysis demonstrates a sort of antirealism, but the intuitions urge us to believe (like the realist) that physical theory is approaching a logically unified and natural classification. In other words, critical reflection compels antirealist claims and an instinctive feeling compels realist ones. Because the latter are based on an innate feeling, I argue, Duhem would not endorse them as if they were on par with scientifically or logically confirmed hypotheses. For this reason, and because he grants his realist attitude a motivational role, I recommend motivational realism as the proper interpretation—the natural classification, if you will—of Duhem's philosophy.

4. Conclusion. In closing I want to emphasize that other Duhem scholars have reached conclusions that can be seen as sympathetic to my own. For instance, Glenn Joy (1975) also argues that, in Duhem's view, scientific practice is encouraged by the physicist's conviction that physical theory tends to be a natural classification. More recently, Ernan McMullin (1990)

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brings up Fine's concept of a natural ontological attitude (NOA) in conjunction with Duhem's philosophy of science. McMullin suggests that Duhem advocates a realist "natural ontological attitude" because he thought that "even though the convergence of physical theory on the relational structure of the world cannot be demonstrated by the methods of physical science itself, it is the natural attitude for scientists to adopt, and is supported by philosophic considerations of the history of specific theories" (McMullin 1990, 422). I think these aspects of their articles are importantly correct. Even so, because I change the context of the debate about how to classify Duhem's work, in the end I draw a significantly different conclusion. I hope I have said enough to make my position plausible. You might notice that nothing I have argued for was meant to defend motivational realism and, in Duhem's hands, its heavy use of the distinction between what we might call faith and reason. However, I think arguments for or against motivational realism are more likely to be fruitful if we properly identify and understand one of its most well-developed examples.

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