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THE DUHEMIAN HISTORIOGRAPHICAL PROJECT

ABSTRACT. Duhem regarded the history of physical science as carrying a twofold lesson for the practicing physicist. First, history revealed the slow, groping, yet continuous development of physical theory toward a true description of the relations among natural entities. Second, history also unmasked false explanations and metaphysical beliefs that might seduce the unwary scientist into following an unfruitful line of research. This paper brings forth the central images underlying Duhem's historiographical project and uses the papers by S. Menn and W. A. Wallace to ask what Duhem's enterprise actually meant in practice. I argue that the main question is the following: What is to count as the proper space of historical meaning and explanation? 'Strong' Duhemians, such as S. Menn, purchase the *longue durée* at the cost of making historical agents into completely passive transmitters of conceptual homologies; 'weak' Duhemians, such as W. A. Wallace, shorten the temporal distance between agents and permit thereby a modicum of conflict and negotiation within physical theory while still seeking to preserve long-term conceptual genealogies. Both positions, it is argued, allow insufficient room for actors' categories to determine the space of cultural analysis.

If anyone doubts whether the spirit of Duhem is alive, these two papers must put that hesitation to rest. Steven Menn and William A. Wallace present similar stories of continuity. In each case, a genealogy has been exhibited; hidden conceptual pathways have been documented and exposed with skill; and in each account, a celebrated early modern scientific achievement has been shown to be tied to a tradition, however complex. History, and in this case, the history of science, is regarded as a repository of conceptual traditions. Like Olympian runners passing the torch, the conceptual complexes pass from one thinker to the next – not in a straight line, to be sure, for sometimes the lines of transmission are lost in the mists of the past. But, in the end, the torches are brought home, the routes of transmission mapped, the concept or method delivered safe and sound.[1]

Both contributors believe that their histories, in some sense, vindicate Pierre Duhem's historiographical project. But since they do not explicate Duhem's understanding of history,[2] it seems appropriate to touch briefly upon some of its central features, to ask in what way our contributors have construed the terms of that enterprise, and finally, to ask why it is worth our while to rake through the somewhat neglected texts

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of the distant past in search of resemblances – family ones or otherwise. Along the way, I suppose that we shall need to ask just what might be meant by an 'intellectual tradition'.

Duhem's notion of the history of physical theory had for him no mere decorative role. In *The Aim and Structure of Physical Theory* he subtitles one section, 'The Importance in Physics of the Historical Method' (Duhem 1962, p. 268). There and in *Physics of a Believer*, Duhem represents history as a "progressive evolution" (Duhem 1962, p. 220f) both in the sense that "no physical theory has ever been created out of whole cloth" (Duhem 1962, p. 221) and in the sense that logic alone cannot justify the choice among physical theories. In a famous formulation, Duhem writes: "It is not possible to compare an isolated consequence of theory with an isolated experimental law. The two systems must be taken in their integrity: the entire system of theoretical representations on the one hand, and the entire system of observed data on the other." This process of comparing entire systems of representation does not happen overnight. It is a slow, evolutionary movement guided by *bon sens* and characterized by "the hesitations, the gropings and the gradual progress obtained by a series of partial retouchings".[3] One observes this movement both in the long history of universal attraction and in the relatively short history of the formation of electrodynamic doctrines between 1819 and 1823.

Given this involvement of science history in both discovery and justification, Duhem believes that certain beneficial consequences follow. First, he thinks that history can assist the physicist broadly in avoiding seductive explanatory fads – "the gossip of the moment", "unreasoned exaggerations of the present time", "the mad ambitions of dogmatism as well as the despair of Pyrrhonian scepticism".[4] Here Duhem was undoubtedly influenced by the example of the history of philosophy in the nineteenth-century French philosophy curriculum; history of science, like its counterpart, could exhibit to the physicist the uncertainty spawned by differing opinions, systems, and philosophical sects (Goldstein 1968; Fabiani 1983). But, history could also point the physicist toward something more stable and certain. Duhem believes that the history of physical theory over the *longue durée* reveals an increasing correspondence between idealized and actual relations among entities. He reiterates this point using different images, but a *morphological* analogy appears to govern his general sense. "The naturalist", he writes,

considers the diverse organs – vertebral column, cranium, heart, digestive tube, lungs, swim-bladder – not in the particular and concrete forms they assume in each individual, but in the abstract, general schematic forms which fit all the species of the same group. Among these organs thus transfigured by abstraction he establishes comparisons, and notes analogies and differences; for example, he declares the swim-bladder of fish analogous to the lung of vertebrates. These homologies are purely ideal connections, not referring to real organs but to generalized and simplified conceptions formed in the mind of the naturalist; the classification is only a synoptic table which summarizes all these comparisons. (Duhem 1962, p. 25)

The zoologist naturalizes the homologies (i.e., shows that they "correspond to real relations among the associated creatures brought together and embodied in his abstractions" [ibid.]) when he establishes that general resemblances turn out to be actual blood-relationships. In *Physics of a Believer* Duhem provides another suggestive image:

Physical theory is neither a metaphysical explanation nor a set of general laws whose truth is established by experiment and induction: . . . it is an artificial construction manufactured with the aid of mathematical magnitudes; . . . the relation of these magnitudes to the abstract notions emergent from experiment is simply that relation which signs have to the things signified; . . . this theory constitutes a kind of synoptic painting or schematic sketch suited to summarize and classify the laws of observation; it may be developed with the same rigor as an algebraic doctrine, for in imitation of the latter it is constructed wholly with the aid of combinations of magnitudes that we have ourselves arranged in our own manner. (Ibid., p. 277)

One is tempted to regard Duhem's evolutionist account of physical theory as a kind of secularized theology of history – both providential and redemptive – unveiling the Divine Plan as a directed scientific tradition and redeeming the physicist who grasps the natural classifications toward which physical theory moves. Roger Ariew and Peter Barker draw attention to an important image from *Physics of a Believer* where Duhem articulates this directionality in a physicalist idiom:

It is not enough for the cosmologist to know very accurately the present doctrines of theoretic physics; he must also be acquainted with past doctrines. In fact, it is not with the present theory that cosmology should be analogous, but with the ideal theory toward which present theory tends by continual progress. It is not the philosopher's task, then, to compare present-day physics to his cosmology by congealing science at a precise moment of its evolution, but rather to judge the tendency of theory and to surmise the goal toward which it is directed. Now, nothing can guide him safely in conjecturing the path that physics will take if not the knowledge of the road it has already covered. (Duhem 1962, p. 303; Ariew and Barker 1986, p. 149)

As Ariew and Barker notice, Duhem provides in this passage a physicist's image of history – the trajectory of a ball. At any moment in its flight, we cannot know the ball's end-point or, by analogy, no particular artificial classification or 'synoptic painting' can show us the end-point of a physical theory. For history is filled with attractive metaphysical systems and mechanism builders, mere explanatory illusions that sustain our faith in the ultimate discovery of natural law. Only by judging the direction of physical theory over time can the physicist make successful inductions toward natural classification that permit new and old laws to be connected within a single account. Duhem thus appears to subscribe to the following slogan: the history of descriptive laws in science is continuous and progressive; the history of explanatory schemata is neither.[5]

These are the briefest outlines of Duhem's historiographical project as expressed in two of his most explicitly philosophical writings. Consider now how this enterprise was to be put into practice. In *Aim and Structure*, Duhem makes much ado about the history of the "memorable discovery of universal attraction" as an instance of the progressive evolution of physical theory. This history, says Duhem, cannot possibly include everything that the Ancients uttered about the heavy and the light. "Let us retain", says he, ". . . only what prepared the way for the Newtonian theory, *by neglecting systematically everything not tending to that goal*" (Duhem 1962, p. 222; my italics). Later in the essay he informs us that:

> From the first half of the seventeenth century all the materials which were to be used in constructing the hypothesis of universal attraction were assembled, cut, and ready to be put into operation; but it was not yet suspected what an extension this work would have. (Ibid., p. 246)

Duhem's historical method reminds us of the ball in flight. Like Aristotle's projectiles, there is no natural motion without a goal; yet, like Galileo's idealized cannon ball, we must imagine away all terrestrial hindrances. Duhem's method of classifying historical homologies is possible only after all the textual underbrush has been removed.

This is not the place to pursue the reception of Duhem's historiographical project – interesting though that would be. From what we do know at present, however, one conclusion seems clear: Duhem's greatest following came not from physicists and philosophers, but from historians.[6] And from within the canon of general historical writings,

Duhem was perceived as having something strikingly new to say. Duhem made medieval culture and 'the origins of modern science' into significant topics of investigation. As the historian A. Dufourcq wrote in 1913:

> The origins of science are less known than its discoveries. We profit from its conquests, enjoy its benefits without any concern about the source from which they derive. Yet there is no more interesting study. In no domain is human progress secured by some spontaneous and necessary evolution. It is important to know the conditions in which science was born, the conditions in which its progress accelerates so that our future procedures may be better oriented. For this reason the works of Duhem must be highly esteemed. They establish on the basis of vast evidence that the principles on which modern science rests were formulated before Newton, before Descartes, before Galileo, before Copernicus, before Leonardo himself, by the masters of the University of Paris during the 14th century. (Dufourcq 1913; quoted and translated in Jaki 1984, p. 409)

The rhetoric of origins, the humbling of Renaissance authority, the implicit praise of Medieval Christianity, the allusions to Gallic pride all must have carried with them important symbolic meanings within the Republican politics of the fin-de-siecle French historical profession. Not surprisingly, Duhem's work also met with excitement among certain elements of the Church. Jaki cites an interesting review of the third volume of Duhem's Leonardo studies by the Jesuit Father H. Bosmans:

> I remember, many years have gone by since, I was then a student of theology and philosophy, busy with things very different from the science of mechanics. . . . In order to get respite from the metaphysics of the masters of the Middle Ages, or, to tell frankly, to have a laugh for a moment, my camarades and myself read aloud a page from the physics of those old scholastics. To laugh! And how right it seemed to be! The whole world thought the same. We have long since had second thoughts about these outbursts of hilarity. Duhem's book taught me how many prejudices still remain to be corrected. (Bosmans 1914; quoted and translated in Jaki 1984, p. 410)

Duhemian historians praised the discovery of a new site of 'origins' and exulted in the challenge to the autonomy of the Renaissance; but significantly, they did so while ignoring Duhem's metaphysical and epistemological theses. The search for conceptual continuities and homologies linking medieval and early modern science had become an end in itself.

In this comment, I would like to suggest that the quest for continuities and traditions still leaves open certain difficulties that belong squarely on the doorstep of Duhem's account of physical theory.

Both of our papers begin by identifying a *terminus ad quem*. Wallace

identifies this as a certain conception of science – a "mathematical physics" he calls it, characterized by a certain ideal of reasoning found in the *Posterior Analytics*; a form of reasoning that Galileo displays in a certain type of analysis of local motion. For Menn, the *explanandum* is more limited. It is not an entire conception of science, but a specific doctrine, namely, the conservation of motion and, even more specifically, that version of the conservation of motion formulated by Descartes. These termini are, presumably, what Duhem would identify as natural classifications.

Now, before we proceed further, we must ask why these termini have been chosen and not others – for example, William Gilbert's notion of "the magnetic substance common to loadstone and iron and the earth itself" (Gilbert 1958, Bk. II, chap. 1, p. 72) or Giordano Bruno's theory of natural magic. Duhem's own criterion is clear: the terminus must be "the reflection of an ontological order". That is evidently not what we have here. Menn says explicitly: "Descartes is an interesting case, both because he holds a strong and precise (though false) principle of conservation, and because he justifies this principle by an argument from natural theology." By this standard, Menn might have chosen Kepler's solar force law or Kepler's polyhedral scheme for ordering the planets and begun his story with Plato. On the other hand, Wallace makes no reference to the truth status of his terminus in this paper, but in his other writings it seems clear that he believes that Galileo did discover certain truths about nature and that he arrived at these truths from the use of a correct scientific method.[7]

So much for the problem of the *ad quem*; but where do we seek the *terminus a quo*? Here, fortunately, Duhem showed the way. For, as we know, since Duhem was the first to track down the conceptual lineages and since he initiated this undertaking nearly a century ago in quite a different context than our two authors, we can well understand his biases, in part because we have the benefit of hindsight. Duhem's *termini a quo* were all Parisian. This is because he believed that Paris was the eternal city, that everything good came from Paris,[8] including, of course, the famous Condemnations of 1277 and the method of hypothetical reasoning *de potentia Dei absoluta*. And, even in his own time, Duhem continued to look to Paris for all good ideas in physics – an attitude not shared by our authors, although the attitude is not unknown among many colleagues in literature, fashion design, and the culinary *scientiae mediae*.

Thus, we cannot allege that our contributors suffer from Parisocentrism. Yet, in different ways, they wish to recommend to us the method of filiations that led Duhem to Paris. Professor Menn wishes to take us back to Mecca via the medieval Arab Avicenna, while Professor Wallace has been edging further away from the High Middle Ages and now focuses his gaze on the Scholastic presence in the Mediterranean Basin from about 1550.[9] For Wallace, while the genealogies to medieval Paris, Oxford and Rome can still be made, his recent studies of Galileo's sources concentrate principally on sixteenth-century materials that now spread out from Rome to Jesuit academic outposts in Salamanca and Coimbra. In short, Professor Menn is, in a sense, closer to the original Duhem in searching out *causae remotivae*, while Professor Wallace's *causae* are *proximiorae*.

Does this make a difference? I think that it does. In my opinion, Professor Menn is forced into a more difficult position because the temporal and, I think, also the cultural distance is too great to sustain a common space of meanings. Let me mention some of these difficulties. First, we have no evidence that Descartes knew or understood Avicenna's notion of *mayl* at all, let alone through a source discussed by Menn. This leaves Menn arguing for a "strong possible resemblance". Second, Menn must explain why it is that Descartes's views *differ* or *diverge* so much from Avicenna's. Avicenna, for example, denies that heavenly bodies have an intrinsic source of motion and concludes that they do not resist constant motion. Yet, writes Menn, "Descartes claims that *any* bodies have an intrinsic source of natural motion and concludes that *no* bodies resist the constant motion". How and why does Descartes accomplish this? Professor Menn says that "it follows from Descartes' conception of body as pure extension, which is designed precisely to strip bodies of any natures, immanent forms or active powers". Evidently, the notion of body as pure extension does not appear in Avicenna. We are left to wonder, then, how it is that Descartes 'strips down' bodies so completely that no medieval Aristotelian could recognize them. Finally, Menn tells us that, "at a sufficiently abstract level Descartes' theory of the causes of motion is very close to Avicenna". But surely if one pulls the 'historical camera' back far enough, one can connect concepts from all times and places; and it might even be tempting to follow Carl Gustav Jung into the realm of the collective unconscious of seminal archetypes, Arthur O. Lovejoy into a realm of 'unit-ideas' or Pierre Duhem into a lineage of increasingly perfect

homologies. I am not suggesting that Menn would want to go this far, but his tendency to read history for resemblances threatens to blend into a search for conceptual identities.

Professor Wallace's attempt to vindicate Duhem is, I think, more successful because the termini of his analysis are much closer in time. Galileo could, as it were, actually talk to and borrow 'software' from some of his sources. Wallace wants to make sense of Galileo's commitment to a certain view of science and to make sense of fragments of a scholastic calculatory vocabulary (especially the *uniformiter difformis* expression). In this kind of story, there are at least hints of a history of science that moves away from Duhem's philosophical history of disembodied concepts, one that acknowledges the *integrity* of particular cultures within which specific forms of scientific life are discernible.

But, on such a view, notions of 'transmission', 'continuity', and 'source', as well as 'influence' and 'reception' all become deeply problematic. For what, after all, is a 'source'? If it is a text, then it can only acquire specific historical meaning from being read. And since reading is an active, time-bound process, we cannot say that any two people, let alone any two groups, will read the same text in the same way (Chartier 1987, pp. 183–239). Nor can we assume that practices of reading in the seventeenth century, the Victorian age or today are quite the same. Nor can we assume that Domingo de Soto had the same *theological* objectives at the Council of Trent that Etienne Tempier had in 1277. Nor can we assume that Galileo, who was neither a Dominican nor a Jesuit, had the same objectives that de Soto had when he used the expression *uniformiter difformis*.

At the end of his paper, Professor Wallace throws some illumination on this problem. He informs us that Galileo's use of calculatory language was not quite the same as the fourteenth century Mertonians (see Sylla 1987). "Such disparity", writes Wallace, "is readily understandable when one considers that Galileo acquired that language *at several removes* from its initial formulators" (my italics). But again, what is a "remove" if not a different context of meaning that must be understood in its own terms?

The second point that Professor Wallace makes in his conclusion is that the Jesuits themselves did not hold a consistent attitude toward the use of mathematics in the study of nature, that there were tensions within the Order between the mathematicians and philosophers and that the Order papered over these difficulties through censorship. Even

Paolo Valla at the Collegio Romano experienced difficulty in publishing his lectures on logic and natural philosophy in the early 1600s and Giovanni Biancani later encountered resistance when he supported Galileo between 1615 and 1620. Here again we cannot assume that the mechanisms and motives of post-Tridentine ecclesiastical censorship had the same political meanings as Bishop Tempier's Condemnations of 1277. Attention to such political and social factors shows promise of righting an imbalance within Duhem's original account. For Duhem analyzed conflicts between the faculties of theology and arts at the University of Paris in the thirteenth century but failed to carry forward his study along those lines into the sixteenth and seventeenth centuries.[10]

Where, then, does this leave the Duhemian historiographical project? As a practical resource for guiding physicists, it seems to have attracted no significant audience. Even those few physicists who engaged in historical work seem not to have followed Duhem's dicta; if anything, the Quantum revolution encouraged the search for discontinuities.[11] To professional historians, on the other hand, Duhem presented a corpus of texts that simply could not be ignored – however they might be interpreted. And, in pressing for conceptual resemblances between the 'well known' and the 'newly found' he succumbed to that malaise, understandable and common among historians, of *overestimating* the value of an archival find. Nowhere is this more evident than in his notion of 'precursor'. If Alexandre Koyré undervalued Galileo's scholastic debts, Duhem, for his part, had an impoverished notion of 'source'. Too readily he was willing to regard the early moderns as passive recipients of scholastic language and concepts. Thus, Duhem pictures Osiander as a kind of receptacle who transmits unchanged a Greek doctrine while omitting the rhetorical and polemical context of his anonymous 'Letter to the Reader'. Similarly, Duhem's Copernicus in *To Save the Phenomena* voices a 'misguided' methodological realism; but Duhem ignored the way in which Copernicus tried to persuade the Pope that correcting the calendar and the order of the heavens should be part of a common agenda of Church reform (Duhem 1969, pp. 61–91; see also Westman 1987 and Westman 1990).

The Duhemian project, in other words, has tended to regard the 'learning of the schools', (Dear 1988) the inheritance of the universities, as sources that influenced passive historical actors, rather than as *re-sources* that were actively used, altered, emended, believed and – dare

we use the term? – misunderstood and misrepresented by early modern propagandists of natural knowledge. With great subtlety and erudition, both of these papers have laid the groundwork for such an analysis. I do not underestimate for a moment the philological, paleographical and philosophical difficulties that they have had to conquer; indeed, I doubt that we would be able to focus our problem quite so finely were it not for their struggle with these texts. For having brought us to this point, we are all in their debt.

NOTES

[1] The image is consciously Duhemian: "By virtue of a continuous tradition, each theory passes on to the one that follows it a share of the natural classification it was able to construct, as in certain ancient games each runner handed on the lighted torch to the courier ahead of him, and this continuous tradition assures a perpetuity of life and progress for science" (Duhem 1962, pp. 32–33).

[2] For an insightful discussion of Duhem's understanding of physics in relation to history, see Martin (1990).

[3] Duhem (1962), p. 253; On *bon sens* and logic, see Martin (1987).

[4] Duhem (1962), p. 304; cf. p. 270: "By retracing for him the long series of errors and hesitations preceding the discovery of each principle, it puts him on guard against false evidence; by recalling to him the vicissitudes of the cosmological schools and by exhuming doctrines once triumphant from the oblivion in which they lie, it reminds him that the most attractive systems are only provisional representations, and not definitive explanations".

[5] It seems to have gone unnoticed that Thomas Kuhn adopts this position in Kuhn (1957), pp. 264–65. I intend to develop this observation further in a retrospective review of Kuhn's book to appear in a future issue of *Isis*.

[6] Stanley Jaki has assembled a significant quantity of very useful information – much of it in the form reviews of Duhem's books – that permits one to make this statement (Jaki 1984, chaps. 9–10). Unfortunately, Jaki's apologetic and defensive tone compromises many of the judgments he makes about Duhem and his work.

[7] See W. A. Wallace, 'Galileo and Reasoning *Ex Suppositione*', in Wallace (1981), p. 149.

[8] I owe this insight to my colleague Amos Funkenstein.

[9] See his 'Pierre Duhem on Galileo', in Wallace (1981), pp. 303–19.

[10] A. Funkenstein's important study of the transition from medieval to early modern forms of scientific and historical reasoning makes the problem of God's attributes the fulcrum of the analysis in a consistent way such that Duhem failed to provide. Furthermore, Funkenstein explicitly disavows the thesis that medieval theological speculation *necessarily* produced early modern science (see Funkenstein 1986, pp. 360–63).

[11] See, for example, Pauli (1955) and Westman (1984); Fleck (1979); Holton (1973); also De Broglie in Duhem (1962), pp. v–xiii.

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