

Epistemology of a Believer: Making Sense of Duhem's Anti-Atomism

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Pierre Duhem's (1861-1916) lifelong opposition to 19th century atomic theories of matter has been traditionally attributed to his conventionalist and/or positivist philosophy of science. Relatively recently, this thesis has been challenged from the combination of two quite independent lines of historiographical development. The first has to do with the status of the 19th century atomic debates and argues that, during Duhem's lifetime, atomism was not the well-established theory most historians have presented it to be. The second is concerned with the nature of Duhem's philosophy of physics and argues that it was not positivist, conventionalist, or instrumentalist, but in fact compatible with belief in unobservable atoms and molecules. The conclusion to be derived from the blending of the two developments is that Duhem's opposition to atomism was not due to any obsession with the observable realm, but to the precarious state of atomic theories during the beginning of the 20th century. It will be the aim of this paper to (a) present the inadequacies of both the traditional and the new interpretation of Duhem's opposition to atomism and (b) provide a new framework for understanding the latter.

The traditional debate concerning the nature of the atomic debates during the end of the 19th century (Fleck 1963, Nyhof 1988, Clark 1976) has become recently even more complicated due to historiographical efforts trying to reassess the importance of developments in 19th century chemistry for atomism. Scholars have challenged the traditional account that saw the determination of atomic weights as the main requirement for 19th century chemical atomism and took its resolution during the 1860s as strong evidence in favor of the atomic hypothesis.

Ursula Klein, for example, has made the case that the development and use of developed chemical formulae portraying chemical properties of compounds were independent from and did not necessarily entail a commitment to atomism (Klein 2003). Alan Chalmers has also argued recently that "developments in 19th century chemistry paved the way, rather than constituted a case, for an experimentally based and testable version of atomism" (Chalmers 2009, p.188). Paul Needham has gone one step further claiming that, during the course of the nineteenth century, Daltonian atomism was mostly an ad-hoc, non-explanatory theory that lacked any empirical evidence in its favor besides the phenomena it was purported to explain. According to Needham, the phenomena of isomerism and the notion of valency, were not predictions of the atomic hypothesis, but discovered and developed empirically. Moreover, they could be explained and endorsed at the time without any commitment to atomism (Needham 2004).

Needham points to the fact that this assessment of 19th century chemical atomism is not very different from the one Pierre Duhem had made in two essays published in 1892 and 1902 respectively (Duhem 2000, 2002, Needham 1996, 2008). For Needham, Duhem's opposition to atomism was due to difficulties with atomism and based on scientific argumentation. Although not directly concerned with his arguments against chemical atomism, other Duhem scholars also argue that, contrary the traditional portrayal of Duhem as a conventionalist and instrumentalist, his philosophy of physics was in fact compatible with belief in unobservable atoms and molecules (Maiocchi 1985, 1990, Lugg 1990). At the heart of this reinterpretation of Duhem's philosophy lies his concept of 'natural classification' (classification naturelle). It is true, argue the proponents of the new interpretation, that Duhem repeatedly insisted that physical theories are not an explanation but a classification of experimentally established laws, however, he explicitly maintained that the ultimate aim of physical theory is to establish a natural classification of these laws. They argue that, according to Duhem, physical theory is

converging towards a natural classification of experimental laws which, by reflecting the underlying metaphysical order, provides us with information regarding the unobservable realities.

For these authors, Duhem's philosophy of physics was fully compatible with belief in hidden entities and his resistance to atoms was not due to any opposition to scientific explanation or obsession with observability, but to the fact that, at the time, both physical and chemical atomism did not have any explanatory role in physical chemistry. Duhem's critique of atomic theories was not directed to scientific explanation and scientific atomism per se, but against a non-scientific, a priori, metaphysical atomism, on the one hand, and the use of atomistic models as heuristic instruments, on the other.

This interpretation of Duhem's philosophy of physics, however, is not compatible with his attitude vis a vis atoms and molecules. The thesis that Duhem opposed atoms on solid scientific grounds holds good for his 1892-1902 version of anti-atomism. It runs into insurmountable difficulties, however, when applied to Duhem's attitude towards atomism after 1905, when developments in different areas of research were all converging towards the view that the existence of atoms and molecules was not a hypothesis but a reality.

No matter the disagreements regarding the status of atomism during the 19th century, (almost) all historians agree that the atomic controversy was over by 1913, with nearly all opponents and skeptics being swayed by the power of the experimental evidence in favor of atomism. The crucial evidence was offered by Jean Perrin (1870-1942) and his experimental work on 'Brownian movement' (Perrin 1908). In his 1913 seminal book *Les Atomes*, Perrin described 13 independent methods which were used to calculate Avogadro's number, including his experiments on the vertical distribution, mean displacement, and mean rotation of Brownian particles (Perrin 1913). The concordance of results obtained by totally different methods was difficult to resist even by lifelong opponents and skeptics of the kinetic theory like Wilhelm Ostwald (1853-1932) and Henri Poincaré (1854-1912), leaving Duhem and Ernst Mach (1838- 1916) as the only major figures who opposed atomism until they died, in 1916 (Nye 1972). That the atomic debates were over by 1913 is recognized not only by historians, but also by philosophers of science, many of them regarding the calculation of Avogadro number by several independent methods as the exemplar of what it is to be considered as a confirmation of a scientific theory (Among them, to mention only a few, are Nancy Cartwright, Ian Hacking, Deborah Mayo, Clark Glymour, Peter Achinstein, Wesley Salmon). The question that arises is: if Duhem was not an anti-realist with respect to unobservables, why was he so vehemently opposed until the end to all theories concerning the microstructure of matter?

In this paper I offer an explanation of Duhem's opposition to unobservable entities that, taking into account the new historiographical developments, makes also sense of his late anti-atomism. The specific claims I make, fall into three major headings. Firstly, paying attention contrary to the revisionist interpretation I argue that the origin and development of Duhem's philosophy of physics clearly show that it was not compatible with belief in unobservable entities. Although, for Duhem, physical theory was a natural classification of experimental laws that offered an always and more accurate reflection of the underlying metaphysical order, the entities classified were abstract mathematical notions and not micro-entities. Even in its ideal ending point, natural classification (physical theory) would not make any claims about or contain any references to atoms and molecules. Secondly, although I claim that although Duhem's philosophy of physics was not compatible with belief in atoms and molecules, contrary to the traditional view, it was neither conventionalist nor instrumentalist. In order to understand the nature of his peculiar philosophical outlook, we have to regard his thought as a whole and take into account the larger intellectual, cultural and religious context in which it was formed.

(Martin 1991, Paul 1972, 1976, Maiocchi 1985, Jaki 1984). Thirdly, and most importantly, I provide a new framework in which to understand Duhem's argument against atomism in the later phase of his career. I claim that beginning in the late 1890's and continuing throughout the rest of his life, as the evidence for a discontinuous structure of matter was building up, Duhem appealed more and more to history of science in order to support both his ideal of science and his opposition to atomism. According to this interpretation, during his late years, historical evidence played for Duhem the same role that scientifically based arguments had played in the earlier period. The concept of natural classification, although not a realist position, is very important for understanding Duhem's resistance to atomism, as it provides the link between his philosophy with both history of science and the larger intellectual, cultural and religious context.