The Historical Roots of 19th Century Antirealism

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Many features of scientific antirealism were fashioned in 19th century disputes about the nature and reality of forces and atoms. The principals of the 19th century debates – Duhem, Helmholtz, Hertz, Kelvin, Mach, Maxwell, Planck, and Poincaré – were primarily philosopher physicists, whose authority is frequently cited to support contemporary views. Duhem's and Poincaré's work share common themes with contemporary antirealism: separation of science from metaphysics; emphasis on the organizing and predictive power of theories as opposed to their explanatory power; skepticism about unobservable entities (e.g., atoms); cautiousness about inferring the correctness of a theory from its past successes. Their antirealism, however, springs from distinctive concerns. Whereas much 20th century antirealism arises from traditional philosophical concerns about our semantic and epistemic access to unobservables, the 19th century antirealists show little anxiety about a veil of perception. Instead the primary motivation for their positions traces to their concerns as historically informed, working physicists.

In this paper I argue that their antirealist philosophy of science was a contingent, though natural, response to their reflections on the history of science and the state of extant theories. Dissatisfaction with the past and current state of physics led them to reject realist ideals of classical mechanics, and faith in the promise of new analytical theories of principles and abstract representations led them to new antirealist ideals. This unduly neglected story provides an illuminating example of a philosophy of science arising in a particular scientific context and responding to a particular understanding of the history of science in that context. The restoration of these forgotten moorings can shed light on our current debates and understanding of science and serve as a corrective to the often extreme views about science expressed in the philosophical literature.

In a bit more detail: By the 1880-s it had become apparent to working physicists that classical mechanics lacked both the conceptual and mathematical tools to properly describe a host of phenomena: "visualizable" material points or atoms subject to position-dependent central forces, so successful for representing celestial phenomena, were ill-suited to represent electromagnetic phenomena, "dissipative" phenomena in heat engines and chemical reactions, fluid phenomena, etc. Deformable bodies and viscous fluids are conceptually difficult to construct from atom-like material points; shearing forces are incompatible with central force assumptions; frictional and electrical forces are velocity-dependent. Nearly everyone agreed that physics had become a disorganized patchwork of poorly understood theories, each dealing with special cases in its own domain and inconsistent with others, without adequate unified foundations and empirically determined values of microscopic parameters. Lacking coherence, unity, and empirical determinacy, these theories could not claim to be explanatory or realistic. Poincaré referred to this predicament as "the present crisis in physics".

As a result of the crisis, physicists became increasingly pre-occupied with foundational efforts to put their house in order. There was widespread agreement that the most promising physics required more general analytical principles (e.g., conservation of energy and action, Lagrange's and Hamilton's principles) that could not be derived from Newtonian laws governing systems of classical atoms. The abstract concepts (action, energy, generalized potential, entropy, absolute temperature) needed to construct these principles could not be built from the ordinary intuitive concepts of classical mechanics. But the unifying concepts and principles could be developed without recourse to "hidden mechanisms" and independently of specific hypotheses about the reality underlying the phenomena.

This crisis led some 19th century philosopher-physicists to be antirealists. Some espoused local varieties of antirealism (antirealist about some kinds of entities, as Hertz was about forces, but not about physics generally). But others espoused more global forms of antirealism and wondered, as contemporary antirealists do, about the relationship between physics, common sense, and metaphysics, the aims and methods of science, and the extent to which the progress of science, understood as a series of attempts to fathom the depth and extent of the universe, is bankrupt. While their realist colleagues hoped for a unified, explanatorily complete fundamental theory and viewed it as the proper aim of science, these antirealists argued on historical grounds that physics had evolved into its current disorganized mess because it had been driven by the unattainable metaphysical goal of causal explanation. Instead they proposed freeing physics from metaphysics and pursued phenomenological theories, like thermodynamics and energetics, which promised to provide abstract, mathematical organizations of the phenomena without inquiring into their causes. To justify this pursuit philosophically, they proposed a re-conceptualization of the aim and scope of physics that, they argued, would bring order and clarity to science and be attainable: Mach viewed the aim of science as economy of thought; Poincaré viewed it as the discovery of real relations between hidden entities underlying the phenomena; Duhem viewed the aim of physics as a non-literal abstract representation of the phenomena that leads to a “natural classification” (a mathematical organization of the phenomena that is the reflection of a hidden ontological order).

In the paper I draw on the philosophical work of Poincaré and Duhem, on Duhem’s historical work on the history of mechanics, and on his scientific work in energetics to tell this story and extract conclusions. Their historical studies and research in physics persuaded them that atomic theories were hopeless whereas abstract energetic theories would flourish. In this they were only partly right: a physics of principles and a rigorous macroscopic physics were partly vindicated by later developments (due to Einstein in the first case and Truesdell’s school in the second), but the vindication of atomism was also just around the corner (due to Einstein and Perrin). Insofar as they took atomism versus energetics to comport with realist versus antirealist ideals of science, the mixed results of the former debate carry over to the latter debate. And this should make us wonder about the wisdom of attempting to pontificate philosophically on things like the proper aim and form of physical theory given that we may be only responding to historically contingent features of our current and past theories. We should be as humble about our philosophy of science as about our science itself, because nature can surprisingly force us to change our most entrenched historical course.