Newton and Empiricism

CONTENTS

INTRODUCTION

Zvi Biener and Eric Schliesser

Sir Isaac Newton's association with "empiricism"—or rather, the set of traditions that constitutes "empiricism"—was clearly recognized during his lifetime and enshrined by Enlightenment *philosophes* as ideology after his death. Voltaire, for example, famously identified Newton's physics and Locke's metaphysics as the intellectual framework for the Age of Reason. The association became such a significant feature of the intellectual landscape that in the eighteenth century a thinker's relation to Newton was often a matter of self-definition; by way of affinity or difference, it was a means of locating one's advertised position in the philosophical spectrum. The influence of naturalistic and experimentalist thought on Newton was similarly well known. Roger Cotes highlighted it in his polemical preface to the *Principia*'s second edition. And Newton himself, although he cited sources only sparingly, explicitly affiliated himself in the *Principia* with the mathematical-experimental tradition of Galileo and Huygens. Moreover, from the 1690s onward Newton used language borrowed from the Baconian/Boylean experimental tradition; and, as the first Part of this volume demonstrates, his first optical works were set in a Baconian natural-historical mold and were read as such by his contemporaries and successors.

Yet the coupling of Newton and empiricism is not without problems. Some of the best-known "classical Empiricists" (with a capital "E"!) were prominent critics of Newton: Berkeley, for example, famously rejected the Newtonian fluxional calculus. Recent and ongoing scholarship has focused not only on *substantive* differences between these Empiricists (Locke, Berkeley, Hume) and Newtonians (Newton, Clarke, MacLaurin), but also on the *polemics* exchanged between them.[1] Moreover, there were sharp differences among prominent eighteenth-century "Newtonians"—many of whom held a variety of Leibnizian metaphysical commitments—and Empiricists regarding questions central to empiricism: Euler and d'Alembert, for example, debated the limits, if any, of applying mathematics to nature,[2] and Hume demurred from the natural religion and physical theology espoused by the likes of Berkeley, Clarke, and

[1] E.g., Domski (2011), Schliesser (2009, 2011).

[2] Iulia Mihai has taught us this.

Newton. These problems challenge Voltaire's facile historiography to such a degree that explicating Newton's relation to "empiricism" is not a matter of adding minutiae to a broadly well-known narrative, but of constructing the narrative itself.

There is also a related, more reflexive difficulty: Why is the question of Newton's relation to "empiricism" as open as it currently is? The proximate cause may be the revival of philosophical interest in Newton's philosophy and its impact during the last forty years on English-language history of philosophy and philosophy of physics.[3] But it is also undoubtedly a consequence of a diffuse process in which categories inherited from Kantian-Hegelian historiography are interrogated and challenged, while at the same time Kantian-Hegelian first-order positions are giving way to what is sometimes called 'knee-jerk realism' in analytical philosophy or 'speculative realism' in continental philosophy.

By reflecting on these historical trends, we can offer two main reasons for the openness of the `Newton and empiricism' question. These reasons both motivate and structure the present volume. First, as already suggested, there is no single tradition that is "empiricism." Although there is no touchstone work in early modern studies that proclaims the death of the singular 'empiricism' as Charles Schmitt's "Renaissance Aristotelianisms" did for the singular 'Aristotelianism,' scholarship in the past decades has increasingly recognized an untidy heterogeneity of empiricist philosophical positions. Contrary to the implicit message of (particularly Anglophone) undergraduate courses and the more erudite, older reconstructions of philosophy's history on which they are based,[4] there is no body of doctrine in early modernity that was "empiricism" and no set of thinkers who self-identified as 'empiricists.'[5] For example, the temporal third of the classical Empiricists—Hume—certainly acknowledged profound debts to and engaged critically with Locke and Berkeley, but scholars have long known that Malebranche and Bayle were also very important sources.

Rather, our contemporary 'empiricism' refers to a mélange of related ideas that privilege experience, but in manners diverse and often indirect. These ideas may be overtly semantic or epistemological (concerning the origin of mental contents or the ultimate sources of justification), but they can also be methodological (concerning the proper method of discovery and use of evidence), practical and technological (concerning

[3] The revival and incorporation of Newton was lead by J. E. McGuire, I. B. Cohen, Howard Stein, Margaret Jacob, Mary Hesse, Ernan McMullin, Michael Friedman, Alan Shapiro, George Smith, and Bill Harper. Obviously, many other historians of physics and mathematics have made seminal contributions to the study of Newton, and there are many "second-generation" Newton scholars now making significant advances.

[4] E.g., Burtt ([1932] 1954), Russell (1945), Copleston (1959).

[5] There were, of course, empiricks, but they certainly do not match the undergraduate/great book concept of "empiricist."

rules-of-thumb or procedures for developing knowledge through real-world manipulation, but also real-world manipulation for non-epistemic, e.g., medical, ends), or political and moral (concerning the social norms that govern knowledge creation, the sources of authority, and/or the broader goals of human life).[6]

In fact, the very label 'empiricism' has come under attack in recent years by Peter Anstey and his collaborators in the so-called 'Otago School.'[7] They argue that 'empiricism' is an ahistorical category that should be replaced with 'experimental philosophy,' an actor's category whose contrast with 'speculative philosophy' captures more precisely what empiricism's contrast with rationalism was traditionally supposed to capture, but failed. And certainly, Otago has something right. We wholeheartedly endorse their core claim: 'empiricism' is a late eighteenth-century label, and we should take care not to attribute it to any earlier actors. However, 'experimental philosophy' does not do any better at accounting for the multiplicity of historical positions, alliances, and developments. Or, to put it more accurately, it only does better when the scope of 'empiricism' is artificially limited to the undergraduate/great book semantic/epistemological use. If 'empiricism' is understood broadly (as it is understood in this volume), it poses challenges as great as those posed by 'experimental philosophy' and, more importantly, opens the same interpretive possibilities.

With both 'empiricism' and 'experimental philosophy,' the challenges are to articulate in what ways thinkers where 'empiricists' or 'experimentalists,' how their prima facie diversity nonetheless belies a philosophic or phylogenic commonality that merits classification as 'empiricist' or 'experimentalists,' and how such a commonality sheds light on their interactions with their contemporaries and their readings of and readership by their predecessors and successors. The devil, if you will, is in the details. The recourse to details, however, does not indicate the bankruptcy of the primary category—either 'experimental philosophy' or 'empiricism'—but rather suggests that either category is messy enough that a terminological shift cannot clarify it.

That said, there are several interrelated advantages in using 'empiricism' even if we grant that the 'speculative vs. experimental' distinction does justice to important pre-Newtonian, seventeenth-century actors' categories. This volume is concerned with Newton, and Newton himself cannot be subsumed under the tradition of experimental philosophy without serious caveats. The most important of such caveats concerns the central importance of mathematics for Newton's natural philosophy and the fact that his understanding of mathematics and the relation between mathematical knowledge and evidential access to the real world was significantly influenced by non-experimental

[6] Waldow (2010), Wolfe (2010), Schliesser (*forthcoming*).

[7] See Anstey (2005), Anstey and Vanzo (2012).

thinkers like Descartes[8] and by thinkers that, while experimentalists, are more neatly located in the tradition of mixed-mathematics, like Galileo and Huygens.[9] A second caveat concerns Newton's own use of 'experimental philosophy.' Although one of the main advantages of the term is that it was an actor's category, it was not *Newton*'s category until after the publication of the first edition of the *Principia*. The phrase made its first appearance in the context of gravitational research only in the "General Scholium" of the *Principia*'s second edition (1712) and in the context of optical research only in draft queries to the Latin translation of the *Opticks* (1706).[10] It was likely introduced for polemical purposes—to defend Newtonian methodology against Cartesians and Leibniz—and its late introduction, despite Newton's engagement in similar methodological battles in the 1670s, indicates that Newton did not think that the character of his natural philosophy would be rendered obvious to his contemporaries simply by labeling it 'experimental.'

Another reason we favor 'empiricism' in the Newtonian context concerns the nature of system-building in the seventeenth and eighteenth centuries. In the seventeenth century, experimental philosophers were sometimes contrasted with system -builders. Experimentalists favored a more piece-meal approach to knowledge construction and inveighed against what they saw as the epistemic overreach in the architectonic systems of, say, Descartes. This "bottom-up" approach represents much of importance in seventeenth-century experimental philosophy, but it misses the mark when it comes to Newton. Newton was both a mathematical system-builder and an experimentalist.[11] When his system-building efforts were emphasized, it was even possible to put him in the same camp as Descartes (the arch system-builder) and apart from Boyle (the arch experimentalist).[12] Similar impulses can be easily seen in the negative reactions, say, by Leibniz, against Newton's inexplicable gravity. Was Newton, then, an experimental philosopher? We suggest that, phrased this simply, this is not a revealing question. Newton's way of systematizing observational data was sufficiently novel that it reoriented what one may have expected to conclude from experiments.[13] This is a crucial point about Newton's experimentalism that the emphasis on his continuity with earlier "experimental philosophy" (perhaps inadvertently) downplays.

[8] E.g., McGuire (2007), Gorham (2011).

[9] Murray, Harper, and Wilson (2011), Harper (2011), Garber (2012), Kochiras (2013). Newton was also guided by reflection on the ancients, e.g., Domski (2012) and the classic McGuire and Rattansi (1966) and commentary thereof.

[10] Shapiro (2004).

[11] E.g., Dunlop (2012) and essays in the first part of this volume.

[12] See, e.g., Gomez (2012).

[13] See Smith in this volume.

A final reason for our use of 'empiricism' is that one of our main interests is in philosophy itself and its self-constructed narrative history. That is, we are interested in the question of what Newton actually had to do with what eventually became known as 'empiricism,' either narrowly or broadly defined.[14] We believe that our terminology keeps this question firmly in mind. For, recent scholarship has shown that the authority of Newton's natural philosophy was deployed (and challenged) in a number of very important and highly charged eighteenth-century philosophical debates, several of which were crucial to the intellectual currents that drove apart "philosophy" and "science" and untangled "natural religion" and "natural science."[15] There were, of course, the familiar debates over the ontological status of key Newtonian concepts, particularly "absolute space" and "attraction." But there were also the Newtonian attacks on Spinozism,[16] the Humean attack on Newtonian natural religion,[17] and a whole variety of challenges regarding the mathematization of particular forms of inquiry (e.g., Mandeville in medicine, Buffon in natural history),[18] which included arguments from all three classical Empiricists.[19] In none of these debates was there a uniform "experimental" position that can be matched up to a canonical Newtonian stance. The same is true, of course, for the lack of uniformity of "empiricism." Even so, within these debates one can recognize "empiricist" constraints that are shared (or rejected) by participants, while this is not true of "experimental" constraints. In sum, when used with caution, the term 'empiricism' does not obscure any insight that might be gained from a careful study of the heterogeneous seventeenth- and eighteenth-century cultures of taking experience seriously. But there is plenty of work to be done. The essays in this volume exemplify some of the issues that make Newton's relation to these cultures far from well understood.

A second reason for the current openness of the question of Newton's relation to "empiricism" is that our picture of Newton himself has changed significantly in recent decades, and as our picture changes, our understanding of how Newton's contemporaries and successors read him changes correlatively.[20] Of particular importance here

[14] E.g., Fate (2011).

[15] Shank (2008), Schliesser (2011).

[16] Jorink (2009), Schliesser (2012). Ducheyne (2013).

[17] Hurlbutt ([1965] 1985).

[18] Hoquet, T. (2010).

[19] E.g., Domski (2012) on Locke; Jesseph (1993), Guicciardini (1993) on Berkeley; Meeker (2007) and Hazony and Schliesser (2014) on Hume.

[20] For example, Downing's essay in this volume discusses Locke's understanding of Newton's account of creation in *De Grav*, a document that was not widely available before 1962. Smith essay outlines the history of gravitational research in the past three centuries in light of the methodology implicit in the *Principia,* a methodology whose contours have only been fully understood only recently.

is the hard-won understanding of the methodological nature of Newton's achievement in the *Principia*. While Newton's willingness to "stop short" of deep ontological commitments has long been recognized,[21] the complex evidential structure that allowed him to stop short—and crucially, to specify *where* to stop short—has only become clear relatively recently.[22] The importance of this development for understanding Newton's "empiricism" cannot be overstated. While reluctance to engage in ontological speculation is a hallmark experimentalism, Newton's reluctance was of a new sort: principled, highly mathematical, and borne of a deep commitment to the possibility of attaining *certainty* within a properly wielded natural philosophy. While elements of this stance were undoubtedly already present in Newton's early optical papers, the stance developed through the writing and rewriting of the *Principia*, particularly under pressure from hostile and friendly criticism, and given new empirical results.[23] There has also been an increasing body of scholarship on Newton's philosophical matter theory[24] and "chymistry."[25] Although no essays in this volume treat Newton's alchemical works, the subject is significant to understanding empiricism, as it provides a context distinct from the mixed-mathematical one and largely distinct from the Baconian one, at least in so far as it was intrinsically tied to a tradition of procedures that explicitly connected theory and experiment.[26]

Finally, the increased attention—cottage industry, if you will—centered on the renewed translation of the manuscript *De Gravitatione*, which is the most "philosophical" of Newton's works to modern eyes, and has generated significant scholarly work on Newton's relationship to Descartes (and even Spinoza), his metaphysics, his theology (aided by significant efforts of the Newton Project), his views on mathematics, as well as a broad methodological framework that combines conjectural and certain thesis into a coherent natural philosophical and theological whole.[27] All of these certainly give impetus to a reevaluation of the association of Newton with Lockean classical empiricism.

This complexity in Newton's thought and in the nature of "empiricism" itself structures this volume. It is divided in three parts. The first part—"The Roots of Newton's Experimental Method" (by Gaukroger, Jalobeanu, and Hamou)—drives home three crucial points. First, empiricism as a doctrine about the sources and nature of the

[21] See the actors in Wolfe's study below.

[22] Cohen (1982), Stein (ms), Smith (2002) and below, Harper (2011), Belkind (2012).

[23] Biener and Smeenk (2012), Schliesser (2012).

[24] E.g., Brading (2012), Biener and Smeenk (2012), Kochiras (2011).

[25] E.g., Dobbs (1975), Westfall (1980), Figala (2002), Newman (2002).

[26] See Newman (2011); on the connection with optics in particular, Newman (2010).

[27] Works here are too numerous to cite, but special mention ought to be made of McGuire (1995), Stein (2002), and Janiak (2008).

understanding emerged from an earlier Baconian tradition of experimental natural philosophy, as it was practiced by mid-century thinkers in the Royal Society and, as Gaukroger stresses, as it was modified through interaction with the work of system-builders like Malebranche. Second, Baconian experimental natural philosophy was concerned with the discovery and composition of natural philosophical facts through the guidance of experiments whose reporting and interrelations were autonomous from the strictures of a predetermined fundamental ontology or privileged explanatory basis. Jalobeanu details the ways in which such experiments built on one another, formed elaborate experimental series, and, to use a much later phrase, came to have a life of their own. Nevertheless, as Hamou reveals, in certain instances this "experimental life" was tied to theory in surprising ways. Third, as all three essays demonstrate, Newton's work in optics was indebted to this mode of investigation, and his success provides an exemplar through which to articulate the practice of an autonomous, experimentally based natural philosophy.

The second part of this volume—"Newton and 'Empiricist' Philosophers" (by Downing, Gorham and Slowik, Hazony, and Demeter)—deals with Newton's impact on some of the classical Empiricists. Only the first two essays deal with empiricism as a semantic/epistemological doctrine, and both use Leibniz as a foil for Locke and Newton. Downing explores how Newton's success in establishing gravity as a property of matter seemingly challenged Locke's essentialism and the primary/secondary distinction. She shows how Newtonian discoveries occasioned significant philosophical work for Locke and were neither uncritically nor easily assimilated into the Lockean framework. Through this analysis, she further clarifies the nature of Locke's commitments. Gorham and Slowik further demonstrate the tensions between Lockeanism and Newtonianism by highlighting that, in regard to space and time, Locke and Newton employed importantly different types of "empiricism," what the authors term "sensationalist" and "scientific" empiricism. Locke's "sensationalist" empiricism lead him to believe that sensible measures of absolute space and time are doubtful, even if he did not doubt the existence of an in-principle empirically inaccessible absolute space and time. Newton's "scientific" empiricism allowed for empirically established physical theory to be a sufficient guide both to the existence and measure of inaccessible entities.

Hazony and Demeter discuss the tensions between Newtonianism and Humeanism, but their focus is methodological. They both articulate how Newton's method—particularly his concepts of analysis and synthesis—influenced the Humean "Science of Man" and the system of sciences into which it was incorporated. Hazony echoes themes from Part I of this volume and connects Newton's vision of the sciences to Boylean ideals of explanatory reduction. He argues that Hume took from Newton these ideals of reduction and, despite the contrary appearance of the *Treatise*, successfully constructs

a "system" that embodies them. Demeter also holds that Hume's affinity with Newton is primarily methodological and further argues that there is a distinction to be made between the methodology of the *Opticks*, particularly the "Queries," and that of the *Principia*. He argues that Hume's science of man is an application of the first of these to the human being *qua* moral being and that thus Hume's manner of "enlarging the bounds of moral philosophy" by way of the perfection of natural philosophy was radically different than the natural-theological path Newton had imagined. It should be noted that for both Hazony and Demeter, questions of semantics and epistemology take a back seat to questions of scientific method and scientific system-construction.

The third part of this volume—"Newtonian Method in 18th and 18th-Century Science" (by Nyden, Wolfe, and Smith)—deals with Newton's impact on diverse natural philosophical and scientific practitioners in the eighteenth, nineteenth, and twentieth centuries. Nyden shows how both "Continental Rationalists" and "British Empiricists" took up Newtonian experimentalism. Her essay directly undermines the distinction between semantic/epistemic rationalism and empiricism and shows that in order to understand the place of experimentation in the early eighteenth century, we must broaden our understanding of these categories. Wolfe shows how Newtonian methodology itself was variously understood by empiricists, vitalists, and other natural philosophers in the eighteenth century. He stresses the role that analogical transpositions of Newtonian method played in justifying eighteenth-century practices in the life sciences, as opposed to the direct incorporation of Newtonian metaphysical or physical tenets into theory. He shows that such transpositions united a variety of seemingly diverse schools, and thus offers a novel interpretive lens through which to understand Newtonian influence in the eighteenth century. Smith, on the other hand, shows how the research program established by Newton in the *Principia* was faithfully followed and developed into the twentieth century. Smith's essay is the longest in the volume. We believe it constitutes a major landmark in research on Newton and his reception and a capstone to a generation's worth of scholarly inquiry into Newton's methods of inquiry in the *Principia*.

Smith's chapter is also unique in this volume because all the other chapters engage extensively with Newton's *Optics*. And for good reason: in the eighteenth century the optical works were celebrated and could be more easily understood.[28] Yet the *Opticks* is not simply more accessible than the *Principia*; it includes quite a bit of philosophical reflection by Newton, which framed and inspired eighteenth-century responses to him. While the optical works have certainly not gone unnoticed,[29] we hope our volume will inaugurate more scholarly attention to Newton's optical writings, both in philosophical scholarship on Newton as well as in the history of early modern philosophy.

[28] Fontenelle singled these out in his influential obituary of Newton, Gillispie (1978).

[29] See especially the seminal work by Sabra (1981) and Shapiro (1993).

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