THE PRINCIPIA FOR THE COMMON-READER: A NEW TREND IN NEWTON SCHOLARSHIP?

ESSAY REVIEW

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In the past 350 years, Isaac Newton's *Principia* has defeated many readers. Partly, this was due to its style and structure. The reader finds herself confronted with a baroque superstructure of propositions followed by abridged demonstrations conveyed in an unfamiliar language. Passages recognizable today as 'mathematical' or 'physical' are interspersed with metaphysical considerations and with theological and historical references. Often, demonstrations are entirely missing and the structure of propositions is difficult to grasp. In addition, one has the feeling of a book especially written to forbid the easy access. For reasons having to do with priority disputes and personal idiosyncrasies, Newton deliberately made *Principia* difficult to read by appealing to what he insisted to call his 'mathematical way',[1] or mathematical manner of treating problems.[2] The abstruse mathematical style of the Principia has been vividly described by William Wheewell, more than a century ago, thus:

> The ponderous instrument of synthesis, so effective in Newton's hands, has never since been grasped by one who could use it for such purposes; and we gaze at it with admiring curiosity, as one some gigantic implement of war, which stands idle among the memorials of ancient days, and makes us wonder what manner of man he was who could wield a weapon we can hardly lift as a burden.[3]

It is not surprising, therefore, that Newton scholarship gave rise to a whole string of books aiming to translate the *Principia* 'for the common reader'. The beginning was probably made by physicist and Nobel Prize laureate Subrahmanyan Chandrasekhar, with his *Newton's Principia for the Common-Reader* (OUP, 1995). Chandrasekhar's project of translating *Principia* in the language of modern mathematics is, in many ways, a masterpiece. It provides the reader with modern proofs of Newton's propositions, followed by Newton's own proofs, with explanations and extended quotes from the text of the *Principia*. Chandrasekhar's aim is to provide a self-contained guide to understanding the complexities of Newton's *Principia*. However, as George E. Smith has convincingly shown, this way of reading Newton out of context does little justice to Newton's aims, questions and particular solutions.[4] Chandrasekhar masterful reconstruction of the mathematics and physics of the *Principia* often fails to offer an accurate picture of Newton's particular mathematical methods or Newton's particular contributions to dynamics. Somehow

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ironically, it is only by substituting Chandrasekhar's 'common reader' with a well-trained historian of (Newton's) science that the books' purpose is really fulfilled. For any other reader, this attempt of translating *Principia* does little justice to the full complexity of Newton's achievements.

Other attempts to 'translate' *Principia* for other categories of common readers were made by I. B. Cohen, in his extended introduction to *Newton's Principia* (CUP, 1999) and in Niccolò Guiciardini, *Reading the Principia* (CUP, 1999). I. B. Cohen's introduction provides the student with much of the historical and philosophical background; but it does not provide enough mathematical details to be useful in reconstructing each of Newton's demonstrations. Niccolò Guiciardini's *Reading the Principia* is by contrast, explicitly addressing the professional historian of science. It is a rich and sophisticated reconstruction of Newton's mathematical methods in their context and from the perspective of their eighteenth century readers.

More recently, William Harper's *Isaac Newton's Scientific Method*[5] provided the historian of science with useful insights into the amazing empirical work grounding Newton's spectacular superstructure of 'mathematical principles'. Harper's book focuses on Newton's ways of constructing phenomena. It claims that a characteristic of Newton's phenomena is that they are constructed in such a way that "inferences from phenomena realize an ideal of empirical success that is richer than prediction." This richer ideal of empirical success "requires that a theory have those phenomena accurately measure the parameters which explain them" (p. 2). As a result, Newton's theoretical construction is based on what Harper calls 'theory-mediated measurements'. These, in turn, allow the turning of data "into far more informative evidence than can be achieved by hypothetico-deductive confirmation alone" (p. 3). What Harper shows on quite a number of examples throughout the book, is that Newton's phenomena "are not just data. They are patterns exhibited in open-ended bodies of data." For example, gravitational phenomena are "patterns exhibited by the relative motions of satellites and planets with respect to the bodies about which they orbit" (p. 23).

The result of reading Newton in this way leads to a better understanding of the true complexity of the various procedures of constructing the phenomena; and it also discloses rich and insightful details of Newton's method. Harper claims that Newton's method display features which go beyond the hypothetico-deductive model (43-44). First, highly theoretical phenomena replace the traditional hypotheses. Second, phenomena are generated through complex procedures of theory mediated measurements. Third, Newton is interested in investigating approximations and deviations from the theoretical models he proposes: and such deviations count as new theory-mediated measurements, and ultimately as new (and more accurately measured) phenomena.

Harper's book has two great achievements. First, it contributes substantially to a better understanding of the complex and intricate array of empirical data on which Newton's phenomena are based. Second, almost each chapter ends with a lesson for contemporary philosophers of science. This being said, it is also fair to say that neither the reconstruction of the experimental Newton, nor the translation into the language of philosophy of science constitute an easy read. Harper's book is

complex, intricate and requires a substantial amount of specialized knowledge. His ideal 'common reader' has to master a large number of fields: from classical mechanics to functional analysis and from methods of mathematical physics to contemporary debates in philosophy of science.

In conclusion, each of these books had a specialized audience in mind. By contrast, Colin Pask's recent *Magnificent Principia: Exploring Isaac Newton's Masterpiece* (Prometheus Books, 2013) is clearly addressed to a different audience. Pask's common reader is the graduate student. *Magnificent Principia* provides an excellent textbook to be used in class, in parallel with Newton's own text and, perhaps, with some more historically nuanced reconstructions of the context, structure and content of Newton's *Principia*. Some of this additional bibliography is clearly indicated by Colin Pask; each of his chapters ends with brief but very useful lists of "Further readings." The acknowledged purpose of Pask's book is to select the most important propositions of *Principia*, to explain their significance for the development of mechanics, and to translate Newton's results into the modern language of theoretical mechanics. At each stage, the reader is directed by the following questions: "What did Newton do? How did he do it? How does it fit into the scheme of mechanics and its applications? And how do we carry out such things today?" (p. 188). Many chapters contain illuminating examples of Newton at work: from the setting of the problem in Newton's terms to the translation of the same problem in modern terms, and from comparing Newton's working methods with modern approaches in theoretical mechanics. Such examples are used to illustrate and emphasize the peculiarities of Newton's working style: his liberal and opportunistic use of various mathematical methods, his attempt to reach a maximum of (mathematical) generalization; his use of interesting limit-cases and his numerous – and sometimes bewildering – shortcuts.

Used as course material, *Magnificent* Principia clearly provides a useful introduction to reading Newton. The only question is how much extra material does one have to cover in order to understand the min results of the *Principia* in their context, i.e. to grasp the problems and questions Newton had to face while writing his masterpiece. In particular, Pask's sketchy context of the writing of the *Principia* and his portrait of Newton, the man, need to be supplemented with a substantial number of other readings.

Given the complexities of Newton's 'mathematical style', it is not surprising that neither of the recent or less recent attempts to 'translate' *Principia* can stand alone. Taken together, they are nicely supplementing each other, enriching the corpus of recent Newtoniana and providing the student of Newton with substantial help in illuminating the context, structure and thorny philosophical issues so abundant in the *Principia*.

Books cited:

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References

[1] As he claims in the well-known paragraph from the beginning of Book III: "It still remains for us to exhibit the system of the world from these same principles. On this subject I composed an earlier version of book 3 in popular form, so that it might be more widely read. But those who have not sufficiently grasped the principles set down here will certainly not perceive the force of the conclusions, nor will they lay aside the preconceptions to which they have become accustomed over many years; and therefore, to avoid lengthy disputations, *I have translated the substance of the earlier version into propositions in a mathematical style, so that they may be read only by those who have first mastered the principles"* (Newton, I., *The Principia: Mathematical Principals of Natural Philosophy*, trans. B. Cohen, A. Miller Whitman, and J. Budenz (Berkeley: University of California Press, 1999)793).

[2] The wide array of mathematical methods hidden beneath the 'classic façade' of *Principia* has been only gradually revealed, in the past decades, mainly due to the works of N. Guicciardini. See Guicciardini, N., *Reading the* Principia*: The Debate on Newton's Mathematical Methods for Natural Philosophy from 1687 to 1736* (Cambridge: Cambridge University Press, 1999); Guicciardini, N., "Conceptualization and Contextualism in the Recent Historiography of Newton's *Principia*", *Historia mathematica* 30/4 (2003) 407-431. On Newton's complex strategies of publishing and withholding information (and mathematical demonstrations) see Guicciardini, N., "Isaac Newton and the Publication of his Mathematical Manuscripts*", Studies in History and Philosophy of Science Part A*, 35/3 (2004): 244-470.

[3] Quoted by Pask, C., *Magnificent Principia: Exploring Isaac Newton's Masterpiece* (New York: Prometheus Books, 2013), 167.

[4] Smith, G. E., "Essay Review: Chandrasekhar's *Principia*: Newton's *Principia* for the Common Reader", *Journal for the History of Astronomy* 27/4 (1996): 353-362.

[5] Harper, W., *Isaac Newton's Scientific Method: Turning Data into Evidence about Gravity and Cosmology* (Oxford; New York: Oxford University Press, 2011).