Review

Reviewed Work(s): Infinitesimal Differences: Controversies between Leibniz and His Contemporaries by Ursula Goldenbaum and Douglas Jesseph

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however, Argyll's candidate lost. John Simson's nephew, Robert Simson, became Glasgow's professor of mathematics in 1711, holding the chair for a half century and becoming Argyll's "friend and advisor." William Cullen's sheer ability seemed to attract everyone's support, including Argyll's, for his straightforward appointments to positions in Glasgow. Cullen's later appointment to Edinburgh's chair of chemistry, however, was more complicated. Joseph Black, having just finished his medical degree at Edinburgh, also sought the chair. He was favored by his own professors at Edinburgh, including the previous professor of chemistry. But Argyll favored Cullen, and he won. Evidently with the backing of both Argyll and Cullen, Black attained Glasgow's lectureship in chemistry and, a few months later, the professorship of medicine—both having been vacated by Cullen in moving to Edinburgh. Argyll supported John Anderson for the chair of oriental languages at Glasgow but opposed him for the chair of natural philosophy three years later. Anderson nevertheless captured that chair—in a close and contentious professorial vote. Argyll's own choice was totally out of the running in that contest, and so Argyll created the regius chair of astronomy for his man in 1760.

James Hutton and David Hume show that professors were not the only influential Enlightenment thinkers. Emerson barely mentions Hutton but pays much attention to Hume, who was rejected for professorships at both Edinburgh and Glasgow. The 1752 Glasgow failure, Emerson argues, reflected both the Kirk's continued influence in such decisions and the skeptic Hume's own naïveté in misunderstanding Argyll's refusal to support him. Hume thought Argyll lacked sufficient courage to back him, says Emerson, whereas Argyll actually had sound political reasons for refusing to do so.

Although Emerson properly focuses on the social and cultural context of Enlightenment ideas, he does not argue that that context determined those ideas—or that patrons' own versions of various academic subjects determined their choices. In addition, continually embedded in political struggles, Argyll and Dundas each experienced variations in his degree of power. Nevertheless, according to Emerson's central thesis, both patrons exerted great influence on Scottish thought, with Argyll generally recognizing and supporting strong thinkers and Dundas not.

Emerson's readers may desire a somewhat more systematic discussion of Argyll and Dundas themselves in order to better understand their motives and actions; they may at times feel bogged down in detail after detail. They might also want more on the actual strengths and weaknesses of the universities: Edinburgh was quite strong in 1800, for example. Moreover, Emerson readily recognizes that he has not examined every single archive that might contain relevant material. Indeed, the Campbell family archive, he reports, is closed to scholars. Emerson thus realizes that his account—like all histories, after all—may well undergo future changes. However, any new findings and readers' quibbles notwithstanding, *Academic Patronage in the Scottish Enlightenment* is a huge accomplishment.

David B. Wilson

Ursula Goldenbaum; Douglas Jesseph (Editors). *Infinitesimal Differences: Controversies between Leibniz and His Contemporaries.* vi + 327 pp., bibl., index. Berlin/New York: Walter de Gruyter, 2008. €72.90 (cloth).

Infinitesimal quantities arose in exact science of the late seventeenth century in several guises. In calculus, the differential element of a variable was smaller than any finite quantity and was equated to zero in certain contexts, but it was not the same as zero. In geometry, a curve was composed of an infinite number of infinitesimal straight-line segments. In physics, motion imparted to a body by contact with another body or by a force was conceived of as a succession of infinitesimal discrete impulses. Infinitesimals were understood algebraically, geometrically, and physically in ways that complemented each other and gave rise to successful theories.

Gottfried Leibniz's differential calculus was first published in 1684, when he was almost forty years old. His views on infinitesimals evolved in the course of his career, but his mature view was that infinitesimals were fictions. They were akin to negative numbers, which were known as fictitious numbers, or roots of negative numbers, which were known as imaginary or impossible numbers. None of these objects was an essential part of mathematics, but all were effective tools in obtaining new results and methods. Leibniz believed that an approach involving infinitesimals could in principle be replaced by a procedure similar to Archimedes' method of exhaustion.

In essence Leibniz's calculus was a set of algorithms and algebraic procedures that was embedded in the geometrical analysis of curves. In investigating how one quantity changed with respect to another, the researcher graphed the relationship between the two quantities by a curve and then applied calculus algorithms to the study of the curve. The geometrical interpretation of the formalism was essential in making it a meaningful part of mathematics; the calculus was sometimes referred to as "fine geometry." In the eighteenth century, mathematicians such as Leonhard Euler would adopt a very different point of view. The formal algebraic facet of the subject was regarded as paramount, and new concepts, such as the function concept, were introduced to replace geometric notions.

Infinitesimal Differences examines the idea of infinitesimals in the science and philosophy of Leibniz and in some of his contemporaries, including Thomas Hobbes, John Wallis, Blaise Pascal, Christiaan Huygens, and Isaac Newton. The essays are connected by common themes and areas of concern and are an excellent representation of Leibnizian studies today. Philip Beeley documents the influence of Wallis's *Arithmetica Infinitorum* on Leibniz, while Ursula Goldenbaum evaluates marginalia left by Leibniz in books by Hobbes in the Boineburg library. Leibniz's writings on infinitesimals from the 1670s are the subject of essays by Siegmund Probst, Samuel Levey, O. Bradley Basser, and Emily Grosholz. Probst is concerned to clarify Leibniz's early understanding of indivisibles and infinitesimals. In Levey's account, Archimedes emerges as a significant influence and helps to illuminate Leibniz's fictionalism with respect to infinitesimals. Basser analyzes a manuscript passage in which Leibniz attempted to show the impossibility of infinitely small quantities. Grosholz explores some aspects of Leibniz's metaphysics and highlights the importance of "modes of representation" and notation in his mathematical work. Looking at Pascal and Huygens, Herbert Breger identifies the importance of these mathematicians in the development of Leibniz's thought.

Richard Arthur, Levey, and Eberhard Knobloch discuss an unpublished work by Leibniz, *De Quadratura Arithmetica*, dating from 1675. Here one finds an approach to quadratures that is somewhat similar to the method of exhaustion and that is said by Knobloch to anticipate the much later concept of integration as the limit of approximating sums. Arthur finds Leibniz's theory to be Archimedean and rigorous, according to the standards appropriate to the period, and to be virtually identical with the foundations Newton laid out in his work on mathematical physics, in particular in the first book of the *Principia Mathematica.*

Fritz Nagel discusses Bernhard Nieuwentijt's criticisms of infinitesimals and the response to them by Leibniz and Jacob Hermann. Douglas Jesseph examines Leibniz's doctrine of infinitely small quantities, focusing on his fictionalism and the importance for his mathematical work of Hobbes's concept of *conatus.* This concept referred to the tendency of a body to motion—what Hobbes called its "endeavour"—and was adopted by Leibniz in his early study of motion.

If the status of infinitesimals in Leibniz's mathematics is a subject of interest, it is because infinitesimals appeared in his calculus and the invention of this calculus was an immense and original achievement. Levey observes that "Leibniz's dealings with the concept of the infinitely small are more closely interwoven with questions of mathematical practice. Context is important" (p. 116). By comparison, Leibniz's contributions to physics were relatively minor. The interest of his writings in this area arises from the contribution he made to the philosophy of physics rather than to physics itself. In this respect his writings differed from Newton's, where foundational conceptions were deployed in the formulation of propositions of the utmost technical interest. In the final three essays in the volume, François Duschesneau, Donald Rutherford, and Daniel Garber investigate the place of infinitesimals in Leibniz's physics, looking in particular at his concept of force. Leibniz rejected the highly geometrized physics of Descartes in favor of a dynamics of forces. The action of a force on a moving body was understood mathematically to consist of a succession of infinitesimal impulses. Contra the Cartesians, Leibniz maintained that it was necessary to distinguish between the physical phenomena and their mathematical representation. Although infinitesimals do not occur in nature, they are acceptable in the mathematical analysis of motion.

CRAIG FRASER

Sara S. Gronim. *Everyday Nature: Knowledge of the Natural World in Colonial New York.* x + 261 pp., index. New Brunswick, N.J./London: Rutgers University Press, 2007. $49.95 (cloth).

In this absorbing volume, Sara Gronim attempts to uncover the everyday knowledge that colonial New Yorkers used in their daily lives in the seventeenth and eighteenth centuries, from knowledge of the weather, phases of the moon, and the tides to cures for ill health, agricultural practices, and the ability to survey the lands they settled. *Everyday Nature* carefully distinguishes between the in-depth scientific knowledge of