Peter Anstey / The University of Sydney

Three Types of Proof in the Seventeenth-Century Philosophy

This paper examines three quite different types of proof in seventeenth century philosophy. The first type is proof by analysis and by synthesis as found in the *Logique* of Arnauld and Nicole. The second type is proof by experiment in the writings of Newton. And the third type is Locke's notion of proofs as intermediate ideas in the process of acquiring demonstrative knowledge. The paper argues that there is an overarching theory—the neo-Aristotelian theory of knowledge acquisition—that enables us to explain why each of these are all called proofs and how they are related.

Fabrizio Bigotti / Julius-Maximilians Universität Würzburg / University of Exeter / CSMBR Pisa

Demonstratio Quia. Early Modern Medical Induction and its Justification

The paper explores some recently discovered sources on anatomical method (Bassanio Landi, Girolamo Fabrici da Acquapendente, Paolo Galeotti) in the context of the so-called Paduan School of Medicine. Specifically, it focuses on issues of induction and how anatomical findings were progressively endowed with geometrical and mathematical arguments to sustain the attack of Aristotelian philosophers demanding rigorous logical deductions from first principles. In this sense, the paper will describe the medical path to the *demonstratio quia* (e.g. Capivacci, Galeotti) and how it was refined and modified in the context of late sixteenth-century anatomical teaching. Through these examples, I hope to offer a fresh look at the role of empiricism and *historia*, where a new emphasis is laid on the spatial organisation of bodily parts, now seen as geometrically definable parts rather than the result of the implementation of a single system articulating throughout interdependent limbs. In the final part, the paper offers an example as to how Galen's classification of 'ill-composed parts' (*malae compositiones*) could be modified and used to implement this new approach.

DAVID BRONSTEIN / THE UNIVERSITY OF NOTRE DAME AUSTRALIA

The Structure of Aristotelian Demonstration

Aristotle thinks that some demonstrations (i.e., explanatory proofs) are such that both of its premises are indemonstrable--these are the highest demonstrations in a science. What are such demonstrations like? In particular, what are its premises like? What kind(s) of predication do they involve? I take a close look at several key passages in the Posterior Analytics in order to answer this question. The view I defend is that the major premise is a 'per se2' proposition (in which the subject is essential to the attribute that belongs to it) and the minor premise is a 'per se1' proposition (in which the attribute is essential to the subject to which it belongs). If this is right, then in the highest demonstrations in a science, a demonstrable attribute belongs to a subject because of an item their essences share in common. These 'essential-overlap' demonstrations are a significant, and as far as I am aware, unrecognised feature of Aristotle's theory.

JACQUELINE FEKE / UNIVERSITY OF WATERLOO

Ptolemy’s Principles

This paper examines the principles of Ptolemy’s philosophy of science. In particular, I analyze the causal framework he describes in the *Almagest* and *Harmonics*, and I put forward a new interpretation of how this system of causes corresponds to the subject matters of the three genera of theoretical philosophy—physics (or natural philosophy), mathematics, and theology—as Ptolemy defines them in the first chapter of the *Almagest* and as he deploys them in his several texts. What does Ptolemy’s metaphysical framework reveal about what the sciences are about, and how does Ptolemy’s scientific method draw on and appeal to his system of causes when, for instance, he makes decisions concerning which theories to adopt and which to set aside? This paper addresses these questions by examining the basic structure of Ptolemy’s scientific method and analyzing his accounts of principles, causes, and

the three genera of theoretical philosophy. What will become apparent is the close association Ptolemy develops between mathematics and reason on the one hand, and physics and nature on the other.

JIM HANKINSON / THE UNIVERSITY OF TEXAS AT AUSTIN

Mathematics and Physics In Aristotle's Theory of The Ether

Aristotle's science is often castigated for its supposed apriorism. In the context of physics and cosmology, it is said, Aristotle is too eager to infer physical theories from abstract mathematics, without regard to empirical considerations. Here I seek to rebut that charge as it relates to the theory of the fifth celestial element, the ether, and to rehabilitate Aristotle's empiricist credentials; to portray him as attempting, albeit on the basis of severely straitened resources, to produce an empirically-adequate account of the nature and structure of heavens. My account will consider Arsitotle's arguments for the fifth element, how in general his physics relates to mathematics, and the extent to which he thought he was offering the sort of demonstrative account envisaged in *Posterior Analytics*, or something altogether more provisonal, whose criteria of adequacy are not such as to yield anything approaching certainty. Time permitting, I will look more closely at the status and origin of his 'hypotheses', and the extent to which he thinks they can be established with any degree of certainty.

ORNA HARARI / TEL AVIV UNIVERSITY

Arguments from the Essence of Things: Alexander's *Quaestio* III.12

In *Physics* III.7 Aristotle clarifies that the conclusion he draws in the previous chapter (*Physics* III.6, 206b24–26), that there cannot be potentially infinite magnitudes by addition because the universe is finite, does not impinge on mathematics, since mathematicians neither need nor use the infinite (207b27–34). In a fragment preserved in Simplicius' commentary on *Physics* III.7 Alexander of Aphrodisias questions this view, arguing that the lines that geometers can use in their contractions should be shorter than the diameter of the universe. In my paper I examine Alexander's argument in light of his *Quaestio* III.12. I show that rather than basing this contention on his conception of mathematical objects, as a comparison with the other ancient commentators suggests, Alexander argues from the essence of things (ἀπὸ τῆς οὐσίας τῶν πραγμάτων) and thus establishes the conclusion that exceeding the limits of the universe is logically impossible. This examination facilitates a discussion of the respective roles of empirical and logical considerations in arguments propounded in natural philosophy.

DANA JALOBEANU / UNIVERSITY OF BUCHAREST

Bacon's Induction and the Construction of 'Science'

Ladislav Kvasz / Czech Academy of Sciences / Charles University Prague

Proof and Other Sources of Certainty in Descartes' Physics

It is well known that Descartes did not hold the notion of proof in high respect. Instead he considered clear and distinct perception to be the ultimate source of certainty in science. In this paper I will attempt to understand the reasons for this position. I will argue that the source of this attitude lies in his early project of *mathesis universalis* and his attempt to justify the rules used in solving biquadratic equations. I will try to show that the clear and distinct perceptions are meant not as an alternative to proof, but rather as its extension.

JAN PALKOSKA / CHARLES UNIVERSITY PRAGUE

Scientific Proof in Descartes' Natural Philosophy

Descartes seems to have believed that like in other fields, his achievements in natural philosophy had been made possible by a peculiar, methodically controlled procedure consisting in the so-called *deductio* from certain simple, *per se* evident principles. Yet as soon as Descartes embarks on the project of adequate scientific explanation of particular natural phenomena in the *Principia*, he finds himself caught in a disconcerting paradox: while he still maintains his own methodical principles commit him to conceive of the desired scientific explanation in terms of *deductio* of the effects (natural phenomena) from their causes or principles (i.e., from the very nature of substantial items of material reality) with the aid of the established laws of nature, he is quick to recognize that the *explananda*, i.e. particular natural phenomena, are hopelessly underdetermined by those explanatory principles. Descartes's proposed way out consists in introducing inductive observatory elements and hypothetic-deductive treatment into the basic explanatory scheme, and Descartes claims more than once that in spite of these complexities, his treatment of natural phenomena still satisfy his own, considerably strong standards of scientific treatment; and he keeps alluding – somewhat embarrassingly given his initial methodological and metaphysical commitments – at unavoidable instrumentalist and fictitious features such an adjustment seems to bring about. In my contribution the nature and credentials of these claims of Descartes's will be assessed in the light of his general notion of scientific proof.

DIANA QUARANTOTTO / SAPIENZA UNIVERSITY OF ROME

Physical Arguments for the Non-Physical Principle of Nature in Aristotle's *Physics* VIII

In *Physics* VIII Aristotle argues for the existence of an unmoved mover that is the first cause of nature but is neither a natural entity nor the object of natural science. He employs a sequence of arguments based on physical data and principles. This raises the following question: how can one arrive at a non-physical entity from physical premises? I tackle this question by focusing on some steps of Aristotle's line of reasoning that involve inferences from limited to unlimited changes. Further, I argue that Aristotle develops the notion of first cause of nature using the conceptual resources of his physics, but these conceptual resources, once extended from the sphere of the limited to that of the unlimited – in particular, once applied to the mover of an unlimited change – are modified with the result of no longer having a physical meaning.

Marco Sgarbi / Ca' Foscari University of Venice

Demonstration, Explanation and Conjecture in Early Modern Philosophy: Interpreting Aristotle's *Meteorologica* I.7 344 a 5-8

Riccardo Strobino / Tufts University

The Logic of Non-Existents in Avicenna

Matjaž Vesel / Slovenian Academy of the Sciences and Arts

Galileo Galilei's 'Necessary Demonstrations'

During his "first Copernican battle" (1613-1615), Galileo Galilei constantly affirmed that his conclusions are based on "necessary demonstrations" or on "demonstrative and necessary reasons" or on the "demonstrative progression". What does he mean by these expressions? And what exactly is his "method of demonstration"?

The first aim of my paper - its *pars negativa* - is to show that Galileo's "method of demonstration" in seeking a new science of the heavens was clearly not that of "demonstrative regress." In the *pars positiva* of my talk, I will argue, first, that Galileo shared some very general epistemological premises with the Aristotelian tradition of what constitutes proper "science" (*scientia*): that "nature is inexorable and immutable," which must translate into "necessary and eternal scientific conclusions." Second, I will emphasize that his "necessary demonstrations" always occur in pair with "sensory experience" (also: "a thousand experiences," "observations," "sense"), that is, observed, experienced, or perceived phenomena. Third, I will address the question of what constitutes his "necessary demonstrations" based on these phenomena. I will argue that Galileo, as far as his "method of demonstration" is concerned, worked entirely in the Platonic tradition, using mathematical, i.e. geometrical, procedures and demonstrations. More specifically, I will argue that despite his great appreciation for Archimedes, his method was not Archimedean, but Euclidean (that of "pure mathematics"). I will focus on two texts from the period in question, *Discourse on Bodies on or in Water* (1612) and *Letters on Sunspots* (1613), which are usually overlooked in this debate. I will also show that my interpretation is consistent with both Galileo's own characterizations of his method and his practice from his earlier and later works.