Representing Space in the Scientific Revolution. David Marshall Miller. Cambridge: Cambridge University Press, 2014. xiv + 236 pp. $90.

According to Alexandre Koyré's famous narrative, the early modern scientific and philosophical revolution was characterized by the destruction of the finite Aristotelian cosmos and by the geometrization of space. In his book Miller pays homage to Koyré, to whom he owes the insight "that changing conceptions of space were an essential catalyst of the Scientific Revolution" (xi). Contrary to Koyré, however, Miller believes that the new representation of space that emerged during the Scientific Revolution came about "close to the phenomenal ground" rather than "in the metaphysical clouds" (214). This conviction shapes Miller's methodological and theoretical approach. His book aims to provide a history of "spatial epistemology" and to show that the Scientific Revolution was fully accomplished once a centered representation of space, which entailed a "convergent, heterogeneous and anisotropic" framework, was replaced by an "oriented representation of space," which involved a "self-parallel, homogeneous, isotropic" framework (17). According to Miller, this shift was the result of a process of "reciprocal iteration": changing representations of space allowed the development of new theories, which in turn brought about new representations of space.

Miller tries to illustrate this process by means of a "series of connected vignettes" (24). Chapter 2 is devoted to the multicentered representation of space that lays at the basis of Copernicus's heliocentric astronomy. Miller disagrees with available interpretations of the so-called "Copernican question": In his view, what motivated Copernicus to develop a new theory was his perception of a conflict between the descriptions of Ptolemaic astronomy and the explanatory principles of Aristotle's physics. Miller's thesis that the Copernican theory "emerged from a resurgent Averroism in the Renaissance university context" (27–28) is, however, not entirely convincing. For, as Miller himself recognizes, "Averroes' criticism of Ptolemaic astronomy applies even more forcefully to Copernicus," whose "multiply centered representation of space hopelessly complicates physical explanations" (60). Moreover, although Copernicus dismissed Ptolemy's equants, which violated the Aristotelian axiom of circularity, he kept using epicycles and eccentrics, without explaining how they could be accommodated within the solid spheres of planetary motions.

Chapter 3 is devoted to Gilbert's attempt to solve the explanatory problems generated by Copernicus. Miller sets out lucidly how Gilbert "shifted his descriptive framework" (87) by adopting a "geographical" and rectilinear representation of space. In the light of this representation, the third motion that Copernicus had introduced in order to explain how the Earth's axis could remain parallel to itself became redundant. As Miller shows in chapter 4, Gilbert's theory exerted a crucial influence on Kepler. The latter, who in his early works had banished straight lines from the universe, gradually understood that planetary orbits were produced by the combined action of a rectilinear and a circular force. Chapter 5 is devoted to Galileo, a key figure in the elaboration of inertial physics. Also in this case, Miller describes a process of reciprocal iteration: the need to explain phenomena on a moving Earth led Galileo to adopt a new explanatory principle, namely the conservation of circular motion, which, in turn, brought about a descriptive distinction between angular rotations and curvilinear translations. While in the *Dialogue,* Galileo used conflicting versions of the conservation theory, in the *Discorsi* he opted for a "curvilinear theory." At the same time, however, he adopted "an oriented framework by which small-scale phenomena could be approximately described" (147). It is a pity that Miller did not add to his narrative Pierre Gassendi, who tried to build a bridge between the *Dialogue* and the *Discorsi,* by applying Galileo's theory of parabolic motion to the behavior of bodies on a rotating earth. In Gassendi's works, the formulation of the rectilinear principle of inertia occurs alongside a centered representation of space.

It was Descartes's merit to associate the conservation principle with an oriented representation of space. In chapter 6 Miller shows, however, that Descartes did not take this representation, which had its origin in his early work on optics, to be universally valid. Descartes's mature physics of vortices relied in fact on a centered framework. Chapter 7 describes how a critical exchange with Robert Hooke led Newton to apply the parallelogram rule of composition of motions, which presupposed an oriented representation of space, to the derivation of the planetary orbit. It was the assumption of a universally valid oriented framework that allowed Newton to unify terrestrial and celestial physics.

While reading this fascinating book, one keeps wondering why the authors under scrutiny were not aware of the tension between the conflicting representations of space that they were simultaneously adopting. Miller seems to suggest that this lack of awareness was due to the implicit link between description and explanation. It was only with the advent of relativity that the representation of space became "part of physics" rather than a "background assumption" (9).

This book does not introduce us to any unknown theories or facts. Its strength lies rather in the new framework in which it reorganizes well-known historical material. Miller admirably succeeds in his attempt to tell "a wide story of intellectual development," and this makes his book relevant to both a student and a scholarly audience.

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