THE TECHNICALLY MANIFOLDED (CLASSICAL AND QUANTUM) SPACE ONTOLOGY

Edward Slowik, *The Deep Metaphysics of Space* (Cham: Springer International Publishing, 2016), ISBN 978-3-319-44867-1, ISBN 978-3-319-44868-8 (online), 356 pp.

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What is generally called "the problem of space" throughout the history and philosophy of physics is chiefly one which takes the main stage in the writings of scientists, mathematicians, historians and philosophers alike. This centrality is mostly due to the fact that it accommodates many questions and results, coming from multiple areas of human thought.

In this framework, the book *The Deep Metaphysics of Space* tackles the core of the intricacy, namely the ontological status of space. Although it may seem that Edward Slowik focuses on the debate between substantivalism and relationism of Newton and Leibniz, respectively, in fact, it delves into many more ramifications of the problem of space. As such, aside from revealing that the mere rigid framing of Newton as a substantivalist and of Leibniz as a relationist can be flawed, Slowik relates their approaches to the completely new setup of General Relativity. This twentieth-century breakthrough proves a hard nut to crack on its own. The difficulty is both due to the fact that it can be consistently traced back to Newton and Leibniz (equally in a philosophical and a mathematical-physical case), but also since it brings to the table entirely new entities, such as multidimensional manifolds and (affine) connections.

The book is divided in three parts, the first unveiling the classical setup, with details on Newton's and Leibniz's accounts, the second aiming the show the intricacy of the problem when relaxing the substantivalism-relationism duality, while the third focuses on both widening the classical scene, as well as tracing back the Quantum Gravity theory as further as possible.

The focus of the first part (which contains Chapters 1-4) is to describe the problem and the setup of the book. As such, after introducing the reader to the debate between substantivalism and relationism, with their greater exponents, the author points out the difficulties that are inherent to any attempt of rigid framing of philosophical accounts. Therefore, although the premises could be that "Newton's absolute space is the commonly accepted forerunner to modern substantivalism" (p. 4) and Leibniz appears "as a chief early exponent of relationism" (p. 3), matters are

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much more complex. As Robert DiSalle also points out, Newton's account is, at times, wrongly fitted in the absolutist frame. While DiSalle insists on the idea that Newton's *Principia* is mostly about *definitions* than *facts* or *observations* (going all the way to Henri Poincaré's view on physical principles as "definitions in disguise,"[1] Slowik goes on a path that aims to show the "third way" nature of Newton's philosophy. Posits are also expounded in Newton's philosophy and the conclusion that Slowik makes with respect to Newton does little to clear the matters for the latter: "if anything is posited, *infinite* space is posited" (p. 55, emphasis in original).

Furthermore, in what concerns Leibniz, the difficulty resides mostly in the fact that his positions greatly evolved throughout his life and work. In this sense, from a seemingly easy fit to the relationism camp, Leibniz underwent what Slowik terms "shift scenarios" (explained first in Subsection 3.3.2), which, doubled by his complex and, at times, cumbersome monadology, aimed at gluing his ideas together, all but resolves that.

As expected, the space debate is deepened by kinematic and topological considerations, such as speed and *situs*, to use the fundamental term from Leibniz's approach on geometrical space. Regarding the purported relationist Leibniz, a clear point is made, that "the places" of objects in space are rather structuralist in nature ("the place of each thing would still be determined by reasoning," p. 64) and in consequence, strongly contrast relationism.

The second part of the book, comprising Chapters 5-8, unfolds some more complexities involved in the metaphysical study of space. Mechanical, geometrical and topological considerations come into play (e.g. in Chapter 6, that focuses on a holistic side of Newton's spatial ontology), as well as the best known debates, involving Platonism, nominalism, structuralism and instrumentalism. Chapter 5, in particular, takes on the property theory view on space and presents it as regulating kinematics, which makes bodies indispensable to any spatial description. But at the same time, any mechanical interaction and general behavior necessarily depends on the structure of space.

To such a view, critiques appear immediately, mostly due to the modern approaches of General Relativity. For example, the presence of the *specific* affine connection on a manifold proves especially difficult from this point of view, as well as the *intrinsic* metric aspects of any (semi)Riemannian manifold *(M, g)* ("a shift in *g* also shifts the identity criteria of the points of *M* along with it," p. 137). Indeed, we are led to the immediate shift in conclusion, by which "metric voids" (p. 135) are inexistent, either in actuality or potentiality, since the gravitational field permeates throughout the entire space. Thus, in virtue of it being everywhere measurable, space cannot be a property.

Chapter 8 shows that when one considers involving epistemic structural realist considerations, the routes to the deep metaphysics of space can be divided further. For this, to give just an example, Slowik introduces highly technical subdivisions of Structural Realism that account for certain parts of the ontic and epistemic paths towards space, both in the classical and the quantum case.

The third part of the book, with Chapters 9 and 10, makes some throwbacks from the Quantum Gravity setup. For example, metrical considerations of geometrical

space, emphasized in late modernity by Bernhard Riemann, are to be related to Newton's kinematics and dynamics. Topological aspects (settled by Poincaré) can be traced back to Gassendi and later to the Leibniz-Clarke correspondence. The increasingly plausible nominalist account on Quantum Gravity can also be backtracked to early modern writings on void and pre-established harmony. Thus, the recent advances in string theory "can be seen as siding with nominalism over virtual-platonism" (pp. 289-290).

Such a continuous exchange between the Newtonian and the string-theoretical physics is given a central role by Edward Witten, who sees string theory as modifying even "the classical domain."[2] However, Jeremy Butterfield and Chris Isham suggest that the interplay is especially hard to maintain, since string theory faces "a dire lack of data," as well as "conceptual problems,"[3] mostly due to the peculiarities of the mathematical setup — a point that Slowik explains throughout Section 7.2.

Finally, Chapter 11, the Epilogue of the book, follows the evolution of the "standard dichotomy" in the philosophy of space after the 17th century. The banishing of God from space by Huygens is recounted, as well as glimpses on empiricist approaches (Berkeley) and Kant's synthesis of the debate, with sensible traces in the physics and philosophy of Mach.

In many ways, the book *The Deep Metaphysics of Space*" by Edward Slowik is seemingly technical, at times even assuming a "dictionary-outline" approach. This is mostly evident in the sections that insist on defining taxonomy and sub-frameworks which fit parts of the rich philosophical accounts that are discussed (primarily throughout Chapter 8, in particular).

At the same time, one can argue that the philosophical technicalities are unavoidable, as the mathematical and physical counterparts so boldly display. Slowik's attempt to walk the reader to the middle of "the space problem" has the great merits of always keeping the eyes and the perspective as wide open as possible. Like the problem itself, the considerations of this book traverse a hugely ramified network of approaches, each of which can account for bigger or smaller, older or newer viewpoints on space. Seen from such a wide angle and assessing the difficulties (at time, unpredictable) that arise, the book is an impressive display of a wide palette of technical frameworks, which are nevertheless given the flexibility required by continuous glances at mathematics and physics, from classicism to late modernity.

References

[1] DiSalle, R., *Understanding Space-Time, The Philosophical Development of Physics from Newton to Einstein* (Cambridge: Cambridge University Press, 2006), 9.

[2] Witten, E., "The Search for Higher Symmetry in String Theory"*, Transactions of the Royal Society of London* 329/1605 (1989): 349-357 at 349.

[3] Butterfield, J., Isham, C. "Spacetime and the philosophical challenge of quantum gravity", in *Physics meets philosophy at the Planck Scale*, ed. C. Callender and N. Huggett (Cambridge: Cambridge University Press, 2001), 33-89 at 36-37.