

Enrico Bellone, *Il mondo di carta*

The Discreet Charm of Ontology

Massimiliano Badino

Taking a second look at a classic work of your discipline is often a tricky business. At first sight, it is almost impossible to avoid the impolite impression that some of its key questions are old fashioned and some of its answers trivial. This impression might in turn generate a condescending attitude toward the author, which inevitably persuades us of our superior wisdom. But as the reading continues and the cultural context of the book delineates itself, it becomes increasingly clear that it is because of that book—and others of its ilk—that those questions have become old fashioned and those answers trivial. For a classic does not merely disclose new mental spaces; it makes them look familiar, natural, and even comfortable.

Enrico Bellone's *Il mondo di carta* is no exception.¹ The book was published in 1976 by the publisher Mondadori, based in Milan. Both the time and the place of its publication are meaningful. Dominated for half a century by Benedetto Croce's and Giovanni Gentile's idealism, Italian philosophical culture was slow to react to the developments of philosophy of science. It was only in the late 1960s that the ideas of logical empiricism—as well as those of its critics—made their way to the academic world of the peninsula. Key to this process was Ludovico Geymonat. A charismatic figure and an original thinker, Geymonat occupied the first Italian chair in philosophy of science at the University of Milan. During the social and generational turmoil of the 1970s, his multidisciplinary approach, blending logic, philosophy of the physical sciences, and history of science within a Marxist framework, attracted a substantial group of young scholars eager to break with traditional culture. More important, Geymonat, a mathematician by training, was able to bridge disciplinary gaps and to recruit junior scientists who were looking for a career outside the lab. Enrico Bellone, who had just graduated in physics at Genoa, was among them.

The spirit of that pioneering period still emanates from the pages of *Il mondo di carta*. The two introductory chapters are impregnated with the philosophical debates of those years. The issues dear to Bellone's heart are the defense of rationality against Paul Feyerabend's methodological anarchism, the search for a middle way between naive continuity and T. S. Kuhn's drastic incommensurability, the taming of Karl Popper's methodological imperialism, the definition of a role for history vis-à-vis Imre Lakatos's provocative notion of rational reconstruction, and—perhaps most important of all—the overcoming of the distinction between internalism and external-

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¹ Enrico Bellone, *Il mondo di carta* (Milan: Mondadori, 1976) (quotations in the text are from this edition, and all translations are my own). For the English translation see Bellone, *A World on Paper: Studies on the Second Scientific Revolution*, trans. Mirella Giacconi and Riccardo Giacconi (Cambridge, Mass.: MIT Press, 1990).

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ism in history of science. At this point, more than one expert reader will raise an eyebrow. Do we really need to beat those dead horses again? Haven't we already disposed of them? When we read Bellone's book, though, we realize that we have not: we have learned how to live with those questions, but they are still part and parcel of the historian's practice. This is why Bellone's concept of the scientist's dictionary still catches our attention as an intriguing insight. Like a paradigm, but unlike a methodology, a dictionary is something a scientist uses in her daily work, not merely an abstract set of rules for selecting propositions. However, like a methodology, but unlike a paradigm, a dictionary changes because of nature's reactions to our investigations, rather than because of a Gestalt switch. A dictionary includes scientific theories, methodological directives, epistemological and ontological presuppositions, computational methods, and many other items arranged in an ever-changing, deeply interconnected network. Furthermore, a dictionary is constituted by regions of uneven conceptual stability and diverse epistemological weight. Hence, scientific change cannot be reduced to simple operations of adding, discarding, and replacing propositions in the dictionary; rather, it is a continuous process of rearranging and realigning its unstable regions. More important, Bellone insists on the contingent nature of this process. Openly targeting Lakatos's methodology of scientific research programs, Bellone argues that preconceived categories such as "mechanicism" cannot illuminate historical development because nature gives "surprising answers" and scientists are, in turn, surprisingly flexible in adapting their theories.

Although it starts by challenging philosophical prejudices, *Il mondo di carta* ends up undermining historiographical ones. The book is concerned with the physics of the eighteenth and nineteenth centuries, a topic famously, and shamefully, neglected by historians of the discipline. This lack of interest can be variously explained. From the point of view of the seventeenth century, the physics of the Enlightenment represents a plain, albeit intelligent, application of the revolutionary insights of Galileo and Newton. Kuhn, for one, marked this period as the prototypical example of normal science. Of course, nobody ever denied Laplace's ingenuity or Lagrange's mathematical prowess, but the physics of the Enlightenment has always been refused the palm of true revolutionary innovativeness. On the other hand, from the point of view of the twentieth century, the concepts and values of so-called classical physics were often invoked in the stubborn conservative resistance against relativity and quantum theory. Framed between two heroic eras, the physics of the eighteenth and nineteenth centuries frequently suffered dismissive judgments of unfashionableness. Although in the last decades much historical work has stressed the cultural impact of classical physics and highlighted its role in preparing the scientific revolution of the last century, studies on this period have remained comparatively scarce.

In the way it treats its subject matter, however, *Il mondo di carta* is a very unusual book. It does not present a detailed discussion of theories, mathematical methods, and arguments—something that Bellone had offered in other works, such as *Aspetti dell'approccio statistico alla meccanica, 1849–1905*.² Even though clearly built on those works, *Il mondo di carta* has a distinct focus. It zooms in on a handful of well-selected case studies to construct a general narrative of the meaning of Newtonian mathematical physics for scientific culture at large. The central problem of the book is effectively encapsulated in the title, *Il mondo di carta*—that is, "a world of paper." The title echoes a passage from the second day of Galileo's *Discourse Concerning the Two Chief World Systems* where Salviati states that "our discourses must relate to the sensible world and not to one on paper." This is a highly assertive statement that defines, at one stroke, the ontology and the epistemology of physical theories. On the one hand, Galileo says that physical theories ought to account for the real world of our sensible experience; on the other, he adds that math-

² Enrico Bellone, *Aspetti dell'approccio statistico alla meccanica, 1849–1905* (Florence: Barbera, 1972).

ematics serves an ancillary role in this project—to wit, it allows us to know how our sensible experiences are interconnected.

One of Bellone's central points is that the developments of physics in the post-Galilean period made this clear-cut distinction increasingly blurry. The emergence of analytical mechanics, a process spanning several decades from Euler and Lagrange to Jacobi and Hamilton, brought about undreamt-of mathematical tools that created completely new ways of looking at physical phenomena. Bellone touches on this point when he discusses Maxwell's preference for the Lagrangian formalism over the Hamiltonian one. Moreover, these new formal devices proved extremely powerful for dealing with a nature that was much more complicated and rich than previously expected. As Boltzmann showed in the early 1870s, statistics and Hamiltonian mechanics are indispensable companions in the exceedingly complex task of describing the motion of countless colliding molecules. Analogously, the clarification of the relations between electricity and magnetism—the former characterized by directionality, the latter by circularity—required the elaboration of highly sophisticated mechanical models and the calculus of differential operators. For Bellone, the consequence was almost inescapable: “When the awareness of the futility of the opinions according to which the world appeared as endowed by the same structure in the infinitely small and infinitely large came to maturity, the new physical sciences found before them not only a world full of surprises, but also objective problems whose source was in the theories themselves” (p. 165).

Although electromagnetism and thermodynamics—not by chance Bellone's chief examples—made apparent the role of mathematics in decisively shaping the ontology of physical theories, the scientific world was not fully ready to bid *adieu* to common sense. The contraposition between Thomson's and Tait's natural philosophy and Boltzmann's *Bildtheorie*, on which the book hinges, turned out to be the supreme *redde rationem* of two centuries of mounting conceptual tensions. Spurred by Boltzmann's liberal use of mathematical abstraction, Thomson and Tait felt moved to make a potent plea for the Galilean ontology: mathematics is useful, even indispensable, so long as it remains an instrument and not a goal in its own right. The objects of physics are to be found in the sensible world—a conclusion that dovetailed with the glorious tradition of British empiricism. The plea would go largely unheeded, however. In fact, the following century would witness the triumph of a physics increasingly detached from common sense and increasingly attached to paper tools. Granted, the ontologies of the energy-momentum tensor and the wave function are still fiercely disputed, but it seems safe to anticipate that they are nothing like common tables and chairs.

In conclusion, among the several themes populating *Il mondo di carta*, the one that seems to me still conspicuously with us is the issue of the ontology of physical theories. In contrast to much contemporary philosophy of science, Bellone suggests that this issue must be historicized. Galileo's naive hope that the objects of physics could be effortlessly found in a transparent nature was wiped out by the second scientific revolution. Instead, physicists put their objects together by patiently combining experiences that are not mere givens, mathematics that is not mere instrument, and rules of conduct that are not all-pervasive methodologies. Those objects live as much in the world as in the stories that theorists tell about it:

The object Mars and the object caloric do not differ because the former can be pointed to in the starry sky, while the latter cannot: as far as the object Mars and the object caloric are concerned, the issue boils down to indicate a library of texts and memoirs on celestial mechanics and a library of texts and memoirs on the theory of thermal phenomena. . . . The physical world and the objects belonging to it can be defined as the collection, organized in theories, of the propositions we use to discuss the world which we inhabit and which constrains us. Leaving to others the task to raise doubts on the existence of the objective world,

the physical sciences ask reasonable questions about Mars or the caloric and interpret the answers by means of zones of rules. The structure of questions and answers is historically situated because the zones of rules are historically given and are modified by a historical process that involves all dictionaries: an experiment by Vesalius and one by Millikan are not historical examples of the absolute category of experiment as the Galilean explanation of the free fall and the quantum explanation of the atomic structure are not historical examples of the absolute category of scientific explanation. In other words, historical processes are not a repository of edifying examples. A theory of knowledge indulging in absolute categories would be nothing but a catechism in need of a false history. [Pp. 178–179]

Although this emotional affirmation of historical ontology might seem to flirt with Jacques Derrida's deconstructionism or Michel Foucault's archaeology of knowledge (and might be closely reminiscent of the latter's notion of "archive"), there is no such temptation at work here. Bellone is not interested in dissolving the physical object into a conversational web. On the contrary, he wants to point out that the ontological question, when examined through the lens of history, becomes an invaluable window on the dynamics of scientific concepts, practices, values, research traditions, and cultural climates—a reminder that should not be lost on us.

The Logic That Governs Each Step of Scientific Research

Luca Guzzardi

When it first appeared in 1976, Enrico Bellone's *Il mondo di carta* was another tile in the vast and multicolored mosaic of the growing interest of Italian philosophers and historians in the structure and development of the sciences.¹ In the preceding decade, a group of young scholars with a philosophical as well as a physical/mathematical background gathered around the leading figure of Ludovico Geymonat, professor of philosophy of science at the University of Milan. Beginning in the 1930s and 1940s, he had, on the one hand, introduced in the Italian context some threads of Austro-German neoempiricism—mostly polemically, against the idealistic tradition of Giovanni Gentile and Benedetto Croce and their tendency to place the natural sciences under the patronage of philosophy. On the other hand, Geymonat's education in philosophy and mathematics enabled him to investigate concrete historical cases (such as Galileo or the history of the calculus), thus combining epistemology with the history of physics and mathematics.

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¹ Enrico Bellone, *Il mondo di carta* (Milan: Mondadori, 1976). For the English translation see Bellone, *A World on Paper: Studies on the Second Scientific Revolution*, trans. Mirella Giacconi and Riccardo Giacconi (Cambridge, Mass.: MIT Press, 1980) (subsequent citations to this translation appear in the text in parentheses).