Review for *Physics in Perspective*

The Philosophy of Physics

Roberto Torretti, *The Philosophy of Physics*. Cambridge: Cambridge University Press, 1999, xvi + 512 pages. US$??. ISBN: 0 521 56259 7 (cloth) 0 521 56571 5 (paper).

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This is an excellent book, by a very distinguished historian and philosopher of physics. Roberto Torretti is principally known to historians and philosophers of physics through his previous books, *Philosophy of Geometry from Riemann to Poincaré* (1978), *Relativity and Geometry* (1983), and *Creative Understanding: Philosophical Reflections on Physics* (1990). As the first two titles suggest, his *forte* is the history and philosophy of geometry and spacetime physics, especially from the nineteenth century onwards. These two books were recognized as masterly. Torretti showed an extraordinary command of the many topics in mathematics, physics and the history and philosophy of science that were involved in these studies. In addition to scholarship, he showed strong acuity about philosophical issues; and had a very graceful prose style. The same merits—scientific and historical scholarship, good philosophical judgment, and stylistic grace—were equally in evidence in *Creative Understanding*; in which Torretti focussed on specifically philosophical topics about how physical theories in general (not just spacetime theories) represent the world.

Happily, the series continues: Torretti has written another superb book, this time ranging across the whole of the history and philosophy of physics from the seventeenth century to the present. This wide scope is due to the fact that *The Philosophy of Physics* is in Cambridge University Press' new series 'The Evolution of Modern Philosophy': in which each book is to describe how a branch of philosophy has evolved into its present form—the underlying thesis being that philosophy is not about a timeless series of questions, but is shaped by developments across the whole intellectual culture. For philosophy of physics, that thesis is undeniable. The very fact that modern physics took shape in the seventeenth century as a part of philosophy (called 'natural philosophy') bears witness to the close connections between physics and philosophy (or at least a central area of it—metaphysics and epistemology). Furthermore, Torretti stresses in his Preface that 'the theory and practice of physics is firmly rooted in that origin, despite substantial changes ... a vein of philosophical thinking about nature runs through the four-century-old tradition of physics and holds it together. This philosophy *in* physics carries more weight in the book than the reflections *about* physics conducted by philosophers. Our study of the evolution of the modern philosophy of physics will therefore pay much attention to the conceptual development of physics itself.'

As I see it, this conception of how to describe the evolution over 400 years of the philosophy of physics, is dead right. Certainly, it makes for a large and exciting project that makes full use of Torretti's armoury of knowledge, philosophical judgment and literary talents; and it is certainly a conception that meshes well with the aims of this journal.

And so Torretti embarks on a grand tour of the conceptual development of physics from the seventeenth century. There are seven Chapters, as follows: The Transformation of Natural Philosophy in the Seventeenth Century; Newton; Kant; The Rich Nineteenth Century (comprising four Sections—Geometries, Fields, Heat and chance, and Philosophers); Relativity; Quantum Mechanics; and finally, Perspectives and Reflections.

This list of Chapter titles makes it clear that for a brief review to discuss, or even summarize, Torretti's treatment of so large an intellectual territory, is impossible. So I propose to report his discussion of just two topics, chosen from early in the book (Chapters 2 and 4): Newton's views on the cause of gravity, and Riemann's conception of geometry. In doing so, I shall quote Torretti at some length, so as to give a sense of his style; but I stress that there are many equally vivid and judicious passages throughout the book.

My choice of topics is partly due to two desiderata that seem to me appropriate to readers of this journal: viz., (i) to show how Torretti seamlessly combines material from the history and the philosophy of physics; (ii) from a pedagogic perspective, to show how Torretti's discussions could be a valuable historico-philosophical supplement in teaching physics. In particular, this second desideratum prompts me to choose examples from earlier in the book; and to steer away from Torretti's treatment of very controversial issues, such as Chapter 6's discussion of the interpretation of quantum theory—where (unsurprisingly, for these controversies!) I disagree with him.

My first topic, the cause of gravity, comes towards the end of Chapter 2, which describes the Newtonian synthesis—and contrives to overcome its familiarity and bring out what an extraordinary feat of scientific imagination it was. After quoting the 'hypotheses non fingo' passage that Newton added to the *Principia* in 1713, Torretti comments: 'With his talk about the cause of gravity, did Newton mean to say that something was wanting in his theory, which another more fortunate scientist might find? I do not think so. His remark that the force of gravity does not operate like the usual mechanical causes seems designed to warn us that the phenomena effectively *preclude* that kind of explanation that his adversaries foolishly *demanded*. And the curt *satis est* ("it is enough that gravity really exists, and acts according to the laws which we have explained ... ") ...does not encourage any further search for the missing cause. In this matter ... Newton quite resolutely sets the path of future science while still paying lip service to the notions of his time' (p. 79).

My second topic comes from the field that Torretti has made his *metier*: the history and philosophy of geometry from the nineteenth century onwards. Here is how Torretti introduces, in his discussion of Riemann's famous 1854 lecture, Riemann's revolutionary idea that the foundations of geometry need not invoke the idea of rigid bodies. He writes: 'The main obstacle obstructing the progress of geometry in Riemann's intellectual environment was the prejudice that spatial measurements must be carried out with rigid bodies ... This is possible only in a space in which every figure can be moved about undeformed. As we shall see, Riemann spelled out the condition under which this requirement is met and described a spectrum of geometries that meet it, neatly defining their place in his own scheme of things. But he took a much broader view of geometry. He agreed that "metric determinations require that magnitudes be independent of place," but pointed out that "this can happen in more than one way"... The one he chooses for further elaboration in his lecture rests on the assumption that *the length of lines is independent of the way they lie in space, so that every line is measurable by every other.* Under this assumption, spatial measurements require inextensible cords rather than rigid rods. Riemann understood that the tailor's tape is more versatile than the clothier's yardstick' (pp. 162-163).

To sum up: here is a splendid book, remarkable for its wide scope, its erudition—and for the grace and lightness of touch with which it is written.