Conclusions

At the beginning of the 18th century, physics was a subdiscipline of philosophy and its primary task was to solve the problem of bodies (*Body*). By the early 1800s, this was no longer the case. Physics had become an independent discipline, and *Body* was no longer its driving concern. In this book, we have argued that the philosophical reasons for this transformation—and its chief consequences—come into view if the 18th century is analyzed as an era of *philosophical mechanics*. That is, as an age of widespread, long-lasting, and concerted efforts to address *Body* through the integration of *rational mechanics* into *philosophical physics*.

We built our case slowly, chapter by chapter, displaying the rich evolution of philosophical mechanics in the Age of Reason. We have already previewed our conclusions from each of these chapters (see Chapter 1), and so we will not reprise them here. Instead, looking back over the whole, we draw out some conclusions for philosophical mechanics in the Age of Reason.

1. The 18th century closed without a philosophical mechanics capable of addressing *Body*. One reason for this was the enormous difficulty of achieving a rational mechanics for extended bodies in motion. At the start of the century, it seemed that incorporating the rules of collision should be sufficient for the purposes of philosophical mechanics (the problem of collision, or PCOL). By mid-century it was clear that much more was needed; specifically, the incorporation of a rational mechanics of constrained motion (the problem of constrained motions, or PCON). The theory of constraints developed rapidly during the later decades of that century, and the mathematical demands of this theory placed it out of reach of most philosophers at the time.

This brings us to the second reason: the *methods* of the philosophers proved inadequate by themselves for determining the nature and properties of body—or of matter in general—consistent with the demands of rational mechanics. Kant explicitly attempted the task, but with PCOL only, not PCON, in mind; and so he failed. Even Boscovich, who explicitly attempted

Philosophical Mechanics in the Age of Reason. Katherine Brading and Marius Stan, Oxford University Press.
 DOI: 10.1093/oso/9780197678954.003.0013

to provide mid-century d'Alembertian rational mechanics with a physics, fell short. By the early 19th century, *empirical* rather than *philosophical* resources had become the most important source and justification for the physical commitments being integrated into rational mechanics. No longer a *philosophical mechanics*, this is the *physical mechanics* of Laplace and Poisson (see Chapter 12).

The result was a disconnect between the philosophers who continued to pursue *Body* (such as Boscovich and Kant) and those such as Lagrange, Laplace, Navier, and Cauchy, whom we regard today as physicists.

2. Physics emerged at the *end* of the century as an independent discipline, with its own resources, methods, criteria for success, and also its own community of researchers. In resources, it no longer deferred to philosophy for either its ontology or its principles. For its methods, it combined those of the mathematician (in rational mechanics) with empirical methods—for the articulation and justification of both principles and ontology, and for criteria of success.

Contrary to narratives in which Newton's *Principia* is the culmination of the scientific revolution, ushering in a stable period of classical physics, in reality "physics" as we know it took another century or more to emerge. Though with hindsight the *Principia* fits the description of the new, independent physics given here, that hindsight is misleading. The *Principia* is consistent with philosophical physics *succeeding* in addressing *Body*, and thereby providing (from *outside* Newton's book) an account of the bodies to which Newton's laws apply. The *Principia* sits at the *beginning* of a golden era of philosophical mechanics, when it seemed that things might go very differently, and philosophers might succeed in their task of solving *Body*. It was only after a further century of struggle with *Body* that physics separated itself from philosophy, and this for all the reasons we have detailed in this book.

3. Though our story ends without a solution to *Body*, the problem does not go away. Bodies are all around us: from pebbles to planets, tigers to tables, and pine trees to—most importantly for many areas of philosophy—*people*. Philosophers relied on philosophical physics to provide a general account of the nature of bodies, one that could be presupposed in any other area of philosophy in which human bodies and bodily action play a role. But the task has now fragmented into two. First, as the latter chapters of our book have made clear, by the early 1800s "bodies" were no longer the presumptive objects of physics. The Problem of Bodies has become the more general

Problem of Objects (*Object*), and the ontic disunity described in Chapter 12 shows that no solution was then in sight.[1] Second, even given a solution to *Object*, the task remained to construct from this ontology the bodies of our experience.

The philosopher interested in *Body* will have to tend to both of these tasks. As we have seen, their methods—the approaches and sources of evidence domestic to philosophy—by themselves had proven inadequate. Therein lie deep and lasting epistemological lessons: about our epistemic situation in the world, the methods whereby we may obtain knowledge of the physical world, and the kinds and limits of that knowledge. The philosopher will need to revise the Goal set out in Chapter 1 to reflect the dual task that they face. They will need the methods and results of both rational mechanics and the new physics if they are to make progress. And they will need interpretive tools: *Body* is *their* problem, and no longer that of the physicist; they will need to master the details of the physics so as to unpack the philosophical moves and content as they pertain to *Body*. For this, we have suggested, examining the interplay between principle and constructive approaches to theorizing provides an important means of extracting philosophical insight.

Nature and Action also require revision. The task of determining the "[1] essential properties, [2] causal powers, and [3] generic behaviors" of bodies has been transformed into the task of ascertaining [1] a set of parameters by which to specify the state of an object (or system) and [2] the dependence relations among those parameters sufficient to determine [3] changes in the state of that system, as for example in its spatiotemporal evolution. This discharges the demands of Nature, and the lesson of the 18th century is that we cannot hope to do more.[2] What we can know about the physical world depends on the physical details of us as epistemic agents, and of that world itself in which we are embedded. There is no way to go beyond these limitations, to "know more" or to somehow know other than this humanly-accessible knowledge. And so, for the purposes of *Object*, Action is fully encompassed by the articulation of the dependence relations among the parameters; what remains is to relate this to an account of causation among the bodies of our experience.

[1] See Chapter 1 for the explanation of *Object*.

[2] Notice that in addition to the constructive route for addressing Nature we now have the principle route, and this opens the way to domain-specific, effective theories for which there is no underlying constructive theory (but which nevertheless should not be thought of as "instrumental" just because they are domain-specific).

Clearly, in the wake of the extraordinary developments of the 18th century, there is much for the philosopher to do as they try to develop a philosophical mechanics. But these challenges lie ahead, in the 19th, 20th, and 21st centuries. As for the 18th century, the Age of Reason, it was remarkable for the evolving relationships between philosophy, physics, and mechanics. And for the project we have called philosophical mechanics, it was a golden era.