INTRODUCTION

The Fundamental Complexity of Atomistics

I

IT IS THE MISFORTUNE OF ALL GRAND DOCTRINES TO ENTER INTO CONTRADICTION as they evolve and to be unable to flourish without losing their original purity and clarity. The definitions at their base grow obscure with repeated application. The words themselves abandon their roots as usage tarnishes their etymologies. The well-chosen convention to which these words initially pointed soon becomes a mere rule. In other words, a limited meaning, precise enough to clarify a truly useful idea, calls forth a wider meaning through its very use. The fact that an idea comes to contradict etymologically the very term that represents it by extending its reach in this way does not, in and of itself, constitute a decisive objection to such a notion. Rather, it would be a sign that the idea has left the world of simple definitions to become a veritable categorem.[1]

Léon Brunschvicg[2] shows that, early on, from Democritus to Lucretius, a contradiction took hold within the atomic hypothesis, and that two great doctrines, brought together under the same sign, but with different goals and destinies, moved forward together until the scientific era. Thus, atomism seems to have assimilated its opposite from the very first attempt to expand it. Very quickly it passed from a realistic meaning to a categorematic one. The atom, taken initially as an object of intuition, furnished an opportunity to think in terms of a method for discursive analysis of the phenomenon. A whole world of mingled images and reasons was thus already latent within the first doctrines of atomism. This mingled form would naturally persist when philosophical developments began to enrich the doctrines.

Under these conditions, it may be best to begin with an analysis, and even a dismantling, in order to isolate the disparate elements of doctrines

that hide such varied thoughts under the same name. My goal has been to prepare this analysis and to furnish students with the means and pretexts to classify their ideas. Arguably, my work with individual systems that makes possible an understanding of the whole is not likely to be a distraction to this group. If my analyses have meaning, they will do no more than facilitate the comprehension and especially the comparison of the doctrines. A few clearly detached elements can, in effect, serve as a point of focus. All triangulation requires fixed and clearly visible points. If the elements that I isolate correspond to salient facts, the triangulation I propose can furnish a map for the detailed description of the systems.

Let us start right away with a feature that can help us bring together the scattered chapters of this little book. This feature will show that I myself would hesitate to place in definite opposition the doctrines I have distinguished. It seems to me, in fact, that the two directions identified by Brunschvicg's initial explanation of the atom are so exactly inverse that, more than analytical paths, they indicate a back-and-forth epistemological movement that is equally clear and productive. In other words, the antisymmetry of the doctrines is so perfect that it reveals a certain solidarity in the solutions rather than a heterogeneity of the objects under investigation. In fact, two systems of thought uncovering the same elements, in the same relation, in the same general order, only in opposite directions, are basically reducible to a single form. These two systems, in short, follow the parallel but inverse movements of analysis and synthesis. Rather than being opposed, they are complementary. They are verified one by the other and it would be vain to attempt to destroy their solidarity, to include one by excluding the other.

In the atomistic world, analysis and synthesis have such a precise, material, and general meaning that it may be good to insist on the rhythm of reciprocal proof that these two types of thought, explication, and experiment take with regard to each other.

As one of its main ideas this book will show that it is really the atom that is sought when the phenomenon is analyzed, but that, at the same time, atomism is justified only through synthesis, by indicating how we can develop a *composition*. Proof by means of an ultimate element benefiting from an evident reality, by an atom held in our fingertips as a result of analysis and answering all questions by its mere reality, would be definitive. This would be a sort of absolute analysis that escaped from reciprocity. Such a method would finally replace "why?" with "how?" And yet one question would have been left out, a last refuge of an insurmountable "why?": in effect, who will

explain *composition*? In thinking over the problem, we notice that reasoning that involves the simple composition of two atoms cannot reside entirely in the *nature* of each of the two atoms. Thus, we face two conclusions that are equally necessary yet divergent. On the one hand, if the component element could accommodate all the characteristics of the compound, we would have to conclude that, in reality, there is no composition. And so an explanation that starts off from too substantial an atom is entirely verbal. On the other hand, it is quite certain that the loosest and simplest compositions, such as juxtaposition or mixing, for example, derive at least some of their explanatory power from space. It can be seen in this case that the atom is not self-sufficient, that an *outside* must necessarily be attributed to it, and that relations with the exterior constitute a kind of second-order reality that sooner or later enriches atoms that were once posited as extremely meager. Thus, as many examples will show, either the atom is too rich and the problem of composition—albeit a real one—has no meaning, or the atom is impoverished and composition is incomprehensible.

Hence it is useless to seek an absolute analysis. We will always have to judge an analysis by the synthesis it favors. Similarly, a synthesis will only be understood thanks to a preceding analysis. It is by joining analysis and synthesis that we recognize the full worth of these two modes of thought.

If, therefore, in dealing with a specific problem, we chance upon a reciprocity of movement that is as exactly complementary as the one observed by Brunschvicg at the center of the atomistic account, we have some assurance of possessing a valid explanatory rhythm, on condition of uniting both features. We have an association of thoughts that is at once correct and objective. The *object* is not in one direction over another, or, to put it differently, objectification will not occur by analysis or by synthesis alone, for objectification is produced by the correct and clear pairing of analysis and synthesis. That account's perfect reversibility reconciles the logical and empirical qualities of knowledge. It represents a maximum of homogeneity at the heart of experimental knowledge.

Of course, little of this homogeneity is found in the doctrines of antiquity, and it is quite certain that Brunschvicg could note, between Democritus and Lucretius, the contrast evident in simple thoughts from the moment they differed. Keeping in mind our prior reservations, these two initial forms of atomism can thus serve as indicators that will classify, right from the beginning, the features of our problem. I shall characterize a little more closely these two *epistemological directions*.

II

TO BEGIN WITH, WHAT DIRECTION DOES THE DEMOCRITEAN ACCOUNT TAKE? And, first of all, what is its point of departure?

In this doctrine one starts by breaking outright with the qualities of the phenomenon. Entirely incongruous and even opposite characteristics from those apparent in the phenomenon are attributed to the elementary corpuscles that will determine the whole explanation. In this way the atom will be given *perfect* properties: hardness, immutability, permanence, disposition toward geometric form and symmetry. In essence, initial atomistic thought thus seems a truly audacious theory. It does not hesitate to diverge from experience in order to impose a *rational* view of reality.

It has often been said that the Democritean school was inspired by a true scientific spirit. Yet that is not enough to characterize this school, for the scientific spirit is twofold at the very least, depending on whether it accentuates the theoretical or the experimental side of knowledge. The early Greek atomists seem to me to be headed in the first direction, although they are not aware of it. They believe they are observing, but they are already reasoning. Also, my overall view is compatible with the historical judgment of Bréhier,[3] who recalls the life of travels and observations of Leucippus and Democritus. Henceforth, in following the fate of the Democritean intuition all the way to modern thought we will necessarily face a clearly and economically constructed atomism. We will see a veritable axiomatics of the atom develop along these lines. In other words, this path to understanding atomism will be revealed, in certain respects, to be nothing other than the *corpus* of postulates that are indispensable to a geometric and mechanical explanation of the phenomenon. As a result, I will be able to say, in one of my conclusions, that the atom embodies the sufficient, if not the necessary conditions for a theoretical construction of the phenomenon.

Of course, the point of view attributed to followers of Democritus is not as neatly unified as my extreme schematization of frequently mixed perspectives would indicate. I'm not unaware, in particular, that we are usually justified in recalling the experimental character of their epistemology, especially when it is set off against the metaphysics of opposing schools. But, in my view, the experimental portion of their doctrine, seen from a rationalistic perspective, is weak because it seems entirely incongruous with the body of the general commentary. To the extent it draws its inspiration from the phenomenon, the structure is poorly adapted to the atomistic characteristics

that have been postulated. This structure seeks to recover the phenomenon without following a truly mathematical progression. Had it developed along purely logical lines, following the value given by a rational combination of postulated elements, it might have missed out on a synthesis from an experimental point of view, but, at least, it would have been an intrinsically correct synthesis. Moreover, the circumstances of such a failure might have led to a rectification of the point of departure. On the contrary, since a latent pragmatism constantly distorts logical development, we do not see the conditions of a healthy verification show up in the physical science of antiquity. In the end, an analysis that claims to specify the characteristics of the atom and a synthesis that claims to construct the phenomenon are disjointed. They do not connect, so they cannot verify each other. One might as well say that the experimental and the theoretical efforts of the doctrine obey two uncongenial impulses and that, with Democritus, the scientific mind has not yet been able to draw together two currents that find in their convergence the unity of the phenomenon and rational certitude.

LET US NOW TRY TO IDENTIFY, IN THE EPICUREAN ACCOUNT, THE FEATURE that can provide a new indicator for the classification of an entire category of atomistic doctrines.

With this dominant feature, Epicurean thought, far from breaking with common experience from the outset, willingly takes ready-made properties from the overall phenomenon and carries them over to the explanatory element. To be sure, as I have just pointed out, Democritus, like all positivists, was not able to exorcise the explanation's finality; but, at least, he made a great effort to hide it and to reduce it. While in fact guided by phenomenal characteristics, his system claims to construct them. With Lucretius, on the other hand, the phenomenal characteristic is clarified at the level of explicatory postulates themselves. Brunschvicg provides a demonstration of this in a special case. Freedom is surely what is most difficult to construct.[4] Since Democritean developments do not accomplish it, we find ourselves, within strict Democritean doctrine, affirming a kind of determinism. We should point out that such a determinism is put forward as a hypothesis. No experiment proves it or even points to it. Epicurean doctrines, on the other hand, accord a veritable freedom to atoms with the assumption of uncaused deviation, of the *clinamen*[5] that requires no explanation since it is attributed directly to the atom. Thus, the atom encloses within itself all the exterior properties of freedom. One can appreciate how easy it becomes, in a world with this kind

of relaxed determinism, to insert human freedom with all its characteristics, its development, and its various impulses. But such a deduction immediately has the makings of a vicious circle since we are limited to rediscovering what had been postulated.

And so, on the specific question of the role and the place of freedom in the synthesis of the phenomenon, an opposition can be seen between the two kinds of doctrines that stem from Democritus and Lucretius. In one system, the solution is impossible; in the other, it is, so to speak, too easy. To characterize this opposition by going back to the very essence of the general methods alluded to earlier, we can say that, in the doctrines inspired by Democritus, there is a failure of synthesis. On the other hand, in the doctrines stemming from Lucretius, there is no real in-depth epistemological movement, no real analysis. In both cases, we are far from having associated analysis and synthesis with a view to mutual verification, since we clearly remain lodged within the framework of the initial hypothesis.

Finally, another conclusion follows upon this initial rough assessment, which is that the thought of Democritus, while the most learned, seems to borrow the fewest elements from reality. It will always be associated with an idealist philosophy. By contrast, the thought of Lucretius, less strict and less careful in its choice of bases, seems to be closer to the phenomenon and ultimately more realist.

III

THUS, PERHAPS I WAS RIGHT TO ASSERT THAT ONE OF THE SYSTEMS DOES NOT continue the other and that, after Lucretius, atomism is revisited and rethought from its very foundation and for entirely new purposes. This power of originality and renewal, easily masked by identical terminology, persists in fact in more recent atomistic schools. If my goal were to retrace the historical development of atomistic doctrines—really an unnecessary task after Lasswitz's admirable work[6]—I would find myself frequently called upon to point out the same disparity of methods and the same fragmentation of conclusions. There are perhaps few clearer examples in philosophy of the independence and isolation of doctrines than in the development of atomism. Nowadays scholars who refuse to associate the philosophies of Democritus and Lucretius with modern scientific atomism are numerous. I would venture to go further. The atomistic doctrines of antiquity do not seem to me to have had any real influence in modern times. They did not really inspire the theories of Gassendi, Huygens, and Boyle, nor

Dalton's research. In fact, the basically immediate intuition that gives each of us the fundamental traits of the atomic model cannot be considered real learning. For atomism there is nothing similar to those influences that span the centuries and that, at times muffled, at times conspicuous, carry Platonism, Cartesianism, and pantheism to the very heart of the most varied doctrines, enrich thought, and correlate systems. For example, when Bacon cites Democritus, it is really only to credit his use of the *word* atom. At most, he recognizes in the Greek philosopher the master of a declared and methodical aversion to metaphysics. That should not be enough to suggest that Democritus is the first proponent of experimental and positivist thought. Nevertheless, this opposition to metaphysical thought—however obscure and even inexact it may appear when examined a little more closely—amounts to referring atomism to experience alone. And such recourse to experience, which can give the doctrine a guarantee of permanence, also explains the spread of this doctrine without our even having to speak of influence from thinker to thinker.

In fact, once intuition has taken experience as its point of departure, it can develop further by yielding to the actual power of experience. If, moreover, we add that it *must* develop in this way, namely, that the first task must be to put aside learned suggestions and look at facts with fresh eyes, we will understand that atomism is almost always presented in the history of philosophy as a reaction to history, as a declaration of the right to treat the problem of the real through direct experience.

However, these claims to being scientific fall short, and centuries go by before they can form a general method. Moreover, the metaphysical mind does not relinquish atomistic doctrines through mere statement, and when it comes to the very specific concept of the atom, the most varied ideas—including the most personal—join in clearly arbitrary constructions. Is there a more mixed body of doctrines than atomism taken as a whole? Does it not go from materialism to monadism? From material unity, with a monist quality that is barely distinguished by spatial characteristics, to the most profligate phenomenal diversity? How can we resolve the apparent contradiction between the simplicity and uniformity of the point of departure and the complexity of developments? It may suffice to point out that, on the one hand, what is transmitted is a word and an invitation to experience—a reason for stability and conformity—and that, on the other hand, what unfolds is a philosophy like the others where individual intuition is marked by its own fancy.

As a matter of fact, this atomistic philosophy enjoys such a clear dialectic that, in every period, the same duality and the same divisions among the various ways of conceiving the atom reappear without much variation.

Renouvier pointed out that the pre-Socratic philosophies were divided "into as many doctrines as it may be possible to posit general principles and their opposites to explain the nature and cause of beings."[7]

That is even truer of atomistic doctrines. We can thus hope to find a clear if not rational classification, despite the historical diversity of such doctrines.

IV

SUCH AN OBSERVATION PARTLY JUSTIFIES PERHAPS THE EXPOSITORY METHOD I have chosen in these inquiries. As I have said previously, my goal is to underscore the intuitive traits of atomistic doctrines, to show also how an intuition becomes an argument, and how, finally, an argument seeks out an intuition to become clearer. I found it necessary to dismantle the systems in order to separate out their elements distinctly. Under these conditions, I reserve the right to borrow examples from quite different moments of philosophical development. I shall shuffle periods rather than genres. I shall also discard what is incidental and specifically historical in certain conceptions. The history of philosophy being a history of reason and experiment, it may be useful to delineate the basic principles of a reason and an experiment from time to time. If I thus succeed in identifying some of these essential principles of atomistic philosophy, while providing an initial, provisional classification of its several intuitions and arguments, the reader of this book may then be able to read fuller books more rapidly and compare with greater clarity the innumerable works of atomistic philosophers. It is toward this simple task, a quite preliminary and pedagogic one, that I hope ultimately to have worked.

HERE THEN, IN BROAD OUTLINE, IS THE PROGRAM FOR THESE INQUIRIES. Following the very path of duality that I identified by way of introduction, I have divided my investigations into two series of chapters.

I will start with *atomism related to the realist schools*—the simplest, most naïve of atomisms—endeavoring to show how it fits into a wider realism. However, in order to tackle its examination more readily, I will begin by what I consider to be the intuitive basis of all atomism. Once the means of knowing or the occasions for imagining have been isolated, we will be better placed to appreciate the scope of metaphysical thinking. Then it will be clearer that realist atomism is a metaphysics like any other, which is to say, remote from experimental verification.

Before moving on to the other schools, I will show that realist atomism dismisses an essential problem that needs clarification: the question of phenomenal composition. I will devote a short chapter to it.

In the second part of my work I will then examine, always in the same spirit of free and factitious analysis, various types of atomism that are more or less closely associated with idealist philosophy.[8] I will make the following distinctions:

> *Positivist atomism*, so skillful and so excessive in its restrictions that it sometimes finds a way to pass as realist in its experimental affirmations, all the while being incontestably idealist with respect to the hypothesis that holds it all up;
>
> *Critical atomism*, able to associate with the most varied scientific theses;

And finally I will address the principles of modern scientific atomism. Without going into properly scientific territory, I will identify several philosophical principles that mark modern atomistic thought with brand new traits. It is here that we will see efforts of reason and experiment converge. It will then be a question of recognizing the logic of experimental research, of gathering axioms, of preparing theorems, and of producing the physical *effects* anticipated by mathematical physics. The role and the place of intuitions will be turned upside down. Intuitions will no longer be *established particulars* to be developed and organized, but simply *figures* that give voice to what we say. Modern atomism will come across as essentially discursive, and will take great care to avoid a priori metaphysical intuitions. It will replace initial images with axioms, or, rather, it will accept such images only as figures used to illustrate axioms. In the area of our present inquiry, the *systematics of assumptions* that characterize modern science might be thought to give legitimacy to the term I am proposing of *axiomatic atomism*.

Thus, if my work, in general, is to have meaning for the study of the principles of contemporary science, we should see it as having a cathartic function. It is by knowing traditional metaphysical intuitions in a discursive and detailed manner that we will be more easily able to put a stop to the exaggerated action of these intuitions in an area where they can no longer be any more than metaphors. Faced with matter that is infinitely small, we confront a break in our experience. In order to examine it, reason must be allowed free rein. In other words, contemporary microphysics is the science of a new world, and a "metamicrophysics" must be grounded on new experiments with new categories.