Epicurean Atomic Theory

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Science has been defined as ordered knowledge of phenomena and the relations between them. There can be no doubt that the beginnings of modern science go back to the Greeks; in certain departments, such as geometry, astronomy, and medicine, the affiliation and transmission of ideas is particularly well attested. We must not, however, over look the great difference between the position of the Greeks and that of the modern inquirer. The latter has at his command instruments and appliances of wonderful accuracy and precision for making observations and experiments. The ancients had no microscope, no telescope, no scientific apparatus of any sort save the carpenter s rule and a pair of compasses. In our days every new theory can be directly tested by comparison with the store of facts already accumulated through the ages. With the Greeks this was not so. So scanty was their knowledge that they seldom had at hand any means of checking a new theory beyond the phenomena which it was invented to explain. Under such circumstances, it was inevitable that conjecture and discussion should usurp the part now played by observation and experiment. In science then, as in metaphysics now, each thinker had his own system, starting anew with first principles and reaching conclusions which had no more validity than the premises. The reader must be careful, then, not to confuse ancient atomism with the modern atomic theory, which from the time of Dalton has found its place in the text-books of chemistry. The modern conception of atoms and molecules serves to explain certain definite and detailed facts of chemistry and physics. The theory is the best working hypothesis which the science of Dalton s time could excogitate for explaining them, and until the discovery of Rontgen rays and the radio-active properties of certain substances it held the field. What modifications it will undergo in the physics of the future no man of science will be bold enough to predict. The modern atomic theory, then, was suggested by and meant to explain certain indisputable definite facts of chemical combination and gaseous volume. But these facts were unknown to the ancient Atomists. They put for ward their theory at a time when men s minds were busy, not with the laws of combination of seventy or eighty known elements, but with more fundamental and far-reaching problems. They were in quest of, some permanent and primary element which by its transformations would account for the variety of nature. Controversy

raged over the question, more ontological than physical, whether one such primary element should be assumed or more than one or an infinite number. Some thought they had discovered it in water, some in air, some in fire. It might seem that no progress could be made on these lines, yet gradually there emerged the conception of primary matter with three properties. It must be (1) indestructible or quantitatively constant, (2) immutable or qualitatively constant, and (3) impenetrable. Empedocles assumed four elements, earth, water, air, and fire; Anaxagoras, an infinity of qualitatively unlike particles. Leucippus, the earliest of the Atomists, postulated an infinite number of primary particles, homogeneous and indivisible, but quantitatively different, that is, differing only in shape and size. Already Empedocles had derived the endless difference in things known to sense from the varying combination and separation of his four elements; Leucippus now resolved the qualitative differences of things into quantitative differences, that is, into varieties of position, order, and arrangement of combining atoms, and the different sizes and shapes of the atoms themselves.

Of any scientific theory we are entitled to ask: Is it fruitful? Does it point out the way for further inquiry ? Does it explain one set of phenomena in terms of something simpler? The atomic theory possessed these merits in a high degree. Tried by every test, from the stand-point of modern science it evinces its superiority to all its rivals. And yet it was never popular; we may even say it was unpopular and discredited in antiquity. In this respect it shared the fate of that other great discovery of the Greeks, the heliocentric hypothesis in astronomy. Both alike were uncongenial Greek prejudices and made their appearance long before the world at large was prepared to appreciate them; for the path of progress is not always a straight line, but often more nearly resembles a spiral. Whatever the cause, the mechanical explanation of nature was abandoned by Plato and Aristotle, the acutest intellects of the time, in favour of a teleological system. It was no slight feat to have reduced the world of physical change to modes of matter in motion. But to their main hypothesis the Atomists attached certain corollaries not so well calculated to command universal assent. Body, they held, is the sole reality; nothing incorporeal exists. Motion, again, was taken to be the sole form of energy. And here we may be permitted to remark that the history of modern physical theories as to the constitution of the sensible world is little more than an account of the way in which energy has gradually taken its place alongside of matter as an equally real thing and has tended more and more to replace it altogether. But to the early Atomists in the infancy of science matter and energy were still undistinguished under the single

conception of body; body was the form in which both were imagined. The existence of body is attested by the senses, but motion, in the view of Leucippus and his great follower Democritus, was inconceivable apart from empty space or void, to which they also attributed existence. Here, again, we may note that the meaning of the term existence is enlarged, for the mode of existence of space is not the same as that of body. Moreover, the existence of empty space or vacuum is not directly attested by the senses, but reached by reasoning. It is instructive to compare the procedure of those acute reasoners the Eleatics, who undoubtedly influenced all the physical theories subsequent to them. They argued thus: Motion is impossible without a vacuum; there is no vacuum; ergo, there is no motion. Accordingly, the Eleatic Parmenides regarded the phenomenal world of change and motion as mere illusive appearance. In his view there is no other ultimate reality but the one immutable Being. Leucippus and Democritus may be supposed to argue from the same premiss thus: Motion is impossible without a vacuum; there is undoubtedly motion, for the senses attest it; ergo, there is vacuum, or empty space. But this is a conclusion of reason, precisely as the Eleatic one immutable Being is a conclusion of reason. The senses no more tell us directly of the one than of the other. Thus, on the possibility of motion and the existence of void, Eleatics and Atomists are diametrically opposed; but in spite of this the atom of Democritus inherits most of the characteristics which the Eleatics claimed for their one immutable Being.

This system Epicurus found ready to his hand, and with this he was satisfied. Only modifications in detail were required to adapt it to his purpose. The writings of Leucippus and Democritus, with the exception of a few fragments, have perished. Al most all our knowledge in detail of their speculations is derived from the form given to them by Epicurus and by his follower, the Roman Lucretius, in his celebrated poem, On the Nature of Things. That marvellous work has made a deep and lasting impression on the modern world, particularly on men of science. They have vied with one another in extolling the poet s firm grasp of scientific principles, his clear conception of law in the physical universe, his sympathetic and penetrating observation, his unrivalled power of bringing together scattered facts and embracing them in one comprehensive view, his bold use of the scientific imagination, his in sight into multitudinous hidden processes and motions on too small a scale to be seen, which yet in every way conform to the processes and motions on a larger scale attested by our senses. It was natural, therefore, that Lucretius himself or, at any rate, his master, Epicurus, should be proclaimed as the one true scientific thinker of antiquity. But it is not properly to them that such

praise belongs. The system unfolded in the poem did not originate with the poet or with his master. So far as we can judge, they added very little of real worth; some of their alterations were for the worse, and in one particular they came very near to imperilling the very foundations of the system. The credit to which Epicurus is justly entitled is that of having made a wise selection. Among conflicting theories he chose to stand by the mechanical conception of the physical universe, when it had fallen into disfavour, and unhesitatingly rejected the fashionable teleology. His doing so testifies to his acute intellect and critical insight, but still more to the honesty, fearlessness, and independence with which he invariably followed his convictions. He also popularised the system he adopted and lent it a new lease of life. So much will be readily admitted, but an impartial estimate of his services cannot go beyond this. He made no discoveries in science himself, nor did any Epicurean after him. He rather discouraged the prosecution of physical inquiries of any sort beyond a certain point. His attitude to natural science as a whole deserves careful consideration. He takes it up because, if we are to be happy, we must be released from mental trouble, above all from groundless fears, more particularly the terrors of superstition, the fear of the gods, and the dread of death. With out this strong impelling motive Epicurus would never have engaged in the study of nature at all. His sole aim is to convince himself that these terrors are unreal and imaginary, and if, incidentally, he dis covers a great deal about the constitution of the world and man s place in nature, it is because he cannot otherwise banish these terrors from the mind. Scientific investigation is permissible only so far as it conduces to this end by laying down the true place of man in the system of things. Beyond this there is no need to go. The laboratories, museums, observatories, and other appliances of modern times for research and discovery, would thus be condemned in anticipation as superfluous. Knowledge in itself and for its own sake he regarded as of little worth. And this was no mere passing phase; it expressed the man s fundamental and settled conviction.

Reference has already been made to certain iconoclastic tendencies of Epicurus. We have seen that he disparaged the education which he, like other Greeks, had received at school. Literature fared no better. The whole poetic art he abhorred as “the deadly bait of fiction.” In this sweeping condemnation he agrees with one phase of Plato s many- sided development, represented in the tenth book of the Republic. In banishing the poets both philosophers were actuated by the same narrow fanatical spirit which led the Puritans to shut up the theatres in the interests of morality. The rejection of mathematical studies is, at first sight, harder to

explain. The fact, however, is certain. Before he became an Epicurean, Polyaenus had made great progress in mathematics; after his conversion we are told that he gave them up and unlearned the science. The reason alleged is that in the view of Epicurus, geometry, astronomy, and kindred sciences rested on false premisses, and could not, therefore, lead to true results. His concern was with the real world, in which he could nowhere find points, lines, and surfaces, as defined by the geometer. Again, he could not understand why infinities should not all be equal; he invariably treated them as if they were equal.

And why were line and surface bound to be continuous ? Why could they not be reduced to successions or series of discrete, discontinuous magnitudes? The same objection to the foundations of geometry had already been made by the sophist Protagoras, who in his work on mathematics attacked the hypotheses of the science because they contradicted our sensible impressions. Thus Protagoras held that there was no such thing in nature as a straight line or a perfect circle, and denied that the tangent to a sphere touched it only at a single point. If this objection were valid, the whole of geometry would be a pretended science, which has nothing in real existence for its subject-matter. The same line of attack was afterward developed by the Sceptics, as we learn from Sextus Empiricus. It must be carefully distinguished from the reasons for which the antagonistic schools of Cynics and Cyrenaics for once united in rejecting the mathematical sciences. The ground of complaint of these Socratics was the inutility of the study. None of its students were made morally better by their proficiency. As Aristippus urged, caricaturing, if not echoing, the methods of Socrates: "Every common mechanic has something to say in his craft about good and evil, useful and useless, but these practical considerations never enter into the purview of the mathematician." Whether Epicurus was also moved by these considerations of practical utility, we are nowhere informed. Zeno of Sidon, a later Epicurean, attacked Euclid on different grounds, arguing that the proofs were insufficient and the definitions unsuitable, if not unintelligible; where upon the Stoic Posidonius took up the challenge and wrote in defence of mathematics. In a similar spirit at a later time the Stoic Cleomedes, in a work still extant, defended the current astronomy against Epicurean assaults.

Epicurus, however, has had his modern champions and we will state their case, which is far stronger for astronomy than for geometry. According to them, the rejection of the current astronomy, instead of a reproach, is a crown of glory to our philosopher. They call attention to the fact that the science which he condemned was not the astronomy of today, which rests upon exact observation and theories universally accept-

ed, apart from a handful of earth-flatteners, but something very different. In his time such observations of planetary movements as had been made were few and imperfect, and astronomy was a mass of conflicting theories, a field in which speculation, sometimes of the wildest sort, ran riot. Toward all such speculations he adopted an attitude of cautious reserve. He did not refuse to entertain any of the discordant explanations of celestial phenomena then in vogue, but upon examining and comparing them he found no grounds for preferring one to the other. Certain assumptions granted, they were all more or less probable, they all lacked convincing evidence, and Epicurus was determined to believe nothing of which he was not absolutely certain. Experiment being impossible, he was content to take up an attitude of suspense, excluding no possibility, but waiting for further evidence. This modest attitude, it is maintained, is more becoming to the true man of science than over-hasty speculation, which jumps to conclusions. Supposing this apology admitted for the rejection of astronomy, what have we to say about the foundations of geometry? Here, too, some sort of a case may be made out; for the controversy over Euclid, his definitions, his common notions, his postulates, and the whole basis of his science, we are reminded, is still raging, and we may believe, if we choose, that Epicurus, more far-sighted than his contemporaries, discerned the weak places in the structure. But a simpler explanation is far more probable. In the miscellaneous works collected under the name of Aristotle, there is a short tract on " Indivisible Lines," a model of terse and closely reasoned argument. The writer sets forth first the grounds on which such in divisible units of length are assumed by one set of disputants, then he proceeds to retail the arguments by which another set meet them and attempt to refute them. Now the connection between mathematics and the general theory of the natural world which the ancients called physics was very close.

The indivisible atom was the basis of all Epicurean physics. It seems highly probable, then, that Epi curus himself would incline to the assumption of an indivisible unit of length, a sort of materialised point. If this surmise be correct, he found himself at variance with what we may call the orthodox school of geometers. Their fundamental notions of line and point he could not accept, and, as they were involved in the whole of geometry, he would feel bound to condemn the science as false. As will hereafter be seen, there is some evidence that he did not altogether accept the continuity of motion, but rather re solved it into a series of progressions, each taking place in an instant of time over an indivisible unit of space. His denial of continuous corporeal magnitude would of itself suffice to bring him into collision with the mathematicians; and this

hostility would be strengthened if he also inclined to regard space, time, and motion as in the ultimate analysis not continuous, but discontinuous as made up of discrete minima.

But, be this as it may, it is high time to inquire what scientific principles, if any, our philosopher admitted. He was certainly no sceptic. He did not hold that every statement is uncertain, because as much can be said against it as for it, and, as a necessary consequence, that all science is founded on nothing better than probability. On what general principles, then, did he conceive himself entitled to assert or believe anything ? This inquiry, prelimi nary to his physics, he himself entitled Canonic, because it dealt with the canon or rule of evidence. First, every statement must relate to what is given, to facts or phenomena. Epicurus is not concerned with the grounds on which from one proposition we infer another, the subject of Aristotle's Analytic, but with the far more fundamental question: On what ultimate grounds is a statement of fact based ? All phenomena are either immediately certain or not, and it is possible to pass from the one region where there is immediate certainty to the other region, which is not thus immediately certain; in other words, from the known to the unknown. Such a process is analogous to the modern induction. For deductive logic, the theory of the syllogism and definition, Epicurus had the utmost contempt. On the other hand, the few general and preliminary remarks of which his Canonic consists contain the germs of a thorough going inductive logic. The Epicurean theory of the universe is built upon this foundation. The existence of the phenomenal universe is everywhere assumed. Things exist outside us. We know them only through sense, which alone gives a conviction of reality. This conviction of reality attaches not only to the external objects which are perceived, but with equal strength to the internal states or feelings, especially the feelings of pleasure and pain of which we are conscious. All true belief and assertion, then, must be founded upon our sensations and feelings. What we immediately perceive and feel, that is true.

"We must take into account," he says, "what really exists, and all clear evidence, to which we refer our opinions, for otherwise all will be full of uncertainty and confusion." "If you fight against all your sensations, you will have no standard to which to refer and thus no means of judging even those sensations which you pronounce false." "If you reject absolutely any single sensation without stopping to discriminate between that which is matter of opinion and awaits further confirmation and that which is already present, whether in sensation or in feeling or in any mental apprehension, you will throw into confusion even the rest of your sensations by your groundless belief, so as to reject the test of

truth altogether. If you hastily affirm as true all that awaits confirmation in ideas based on opinion, as well as that which does not, you will not escape error, as you will be taking sides in every question involving truth and error."[1] Or, as Lucretius more graphically expresses it: You will find that from the senses first has proceeded the knowledge of the true and that the senses cannot be refuted. For that which of itself is to be capable of refuting things false by true things must from the nature of the case be proved to have the higher certainty. Well, then, what must fairly be accounted of higher certainty than sense? Shall reason founded on false sense be able to contradict the senses, seeing that reason is wholly founded upon them? And if they are not true, then all reason as well is rendered false. Or shall the ears be able to take the eyes to task or the touch the ears ? Any one sense cannot confute any other. No, nor can any sense take itself to task, since equal credit must be assigned to it at all times. What, therefore, has at any time appeared true to each sense is true."[2]

It is only through sense that we come into contact with reality; hence all our sensations are witnesses to reality. The senses cannot be deceived. There can be no such thing, properly speaking, as sense-illusion or hallucination. The mistake lies in the misinterpretation of our sensations. What we suppose that we perceive is too often our own mental presupposition, our own over-hasty inference from what we actually do perceive. When we see an oar which is half immersed in water appear bent, the image or film which reaches the eye is really bent, but the judgment of the mind that the oar itself is bent is no part of the perception, it is a gratuitous addition to it. The mind confuses two quite distinct processes or movements, the perception which is infallible, and the conscious or unconscious inference from it, which is after all mere presupposition or opinion, a groundless belief. The region of certainty, then, confined as it is to the direct presentation of sense, is even so by no means as extensive as we might at first suppose. Sensations themselves must be scrutinised, and the element which the mind itself has added must be removed before we get back to the original data, the perceptions which put us in touch with reality.

Turning now to the other and vaster region of the unknown, which is not accessible to direct observation because sensation is strictly limited to here and now, we observe that some part of it may hereafter come within our ken and be directly observed. This Epicurus denotes as "that which awaits confirmation." Cognition is an interrogative process. We put the question and wait until experience and reality, under favourable

1 Golden maxims, XXII-XXIV.

2 De Rerum Natura, IV, 478-499.

circumstances, supply the answer. But our knowledge, confined within these limits, would be very inadequate. By what we have above called an inchoate induction Epicurus regulates the steps by which we anticipate all experience with certainty. His fundamental assumption is the uniformity of experience: that whatever occurs in the sphere beyond knowledge must follow the same) laws of operation as what is known to occur within the range of our experience. It is right, then, to affirm about the unknown (1) what is confirmed and witnessed to by the known, or at least (2) what is not directly witnessed against by the known. Thus the criterion, the supreme test of validity, is future experience, experience repeated or, at all events, not contradicted. The second half of this canon is by no means so sound as the first. It is capable of wide application, and must allow many doubtful explanations to pass for matters of belief. What is the ground on which Epicurus believes that there is an infinity of worlds, that the blessed and immortal gods inhabit the intermundia, that films from external objects enter the sense-organs and the mind, thus causing sensation and thought propositions for which there is not a tittle of positive evidence? His reply is: " Nothing that we know by direct observation contradicts any one of these assertions." And so Epicurus gives them, we may say, the benefit of the doubt.

Another caution is needed. If reasoning is to be anything better than mere quibbling, special attention to language is necessary. Every term that is used must call up a clear and distinct conception or idea, which again must be based upon one clear and distinct perception. To general terms, as we shall hereafter see, correspond not single images, but the resultant of an accumulated series of images, the individual peculiarities of which are blunted and fused in a single pictorial type, much in the same way as when the photographs of different individuals are superposed on each other in order to form a composite photograph. But every perception in the series must be clear and distinct, in order that the resultant may have these qualities. In this way we obtain ^ what Epicurus called "preconceptions," which take their place beside perceptions and feelings. They are the nearest approach which his system allowed to general notions. When a general term like "man" is used, it calls up to the mind the preconception of man, the generic type in which the images of particular men are fused and blended. With this explanation and qualification we may even be permitted to substitute "general notion" for "preconception," always remembering that it is an inexact equivalent. It remains to explain what precisely Epicurus understood by reasoning in which general terms are used, and what part it plays for him in the acquisition of knowledge. Sense gives us the raw material of knowledge

in trustworthy perceptions and internal feelings, but he never denied that we also attain knowledge by the exercise of reason. Indeed, all the more important propositions in the general theory to be hereafter unfolded are attained by its aid. Reason or reasoning is to him a mental operation, which deals, not with particular things, but with generic types or notions. If our knowledge did not go beyond sensation it would consist in isolated, particular facts. In that case it would be difficult, if not impossible, to make the inductive leap from the known to the unknown. Reasoning, then, is the application, in a region where direct observation fails, us, of preconceptions or general notions derived from sense, their validity being guaranteed by repeated and uncontradicted experience. But future experience is the sole criterion by which all our reasoned conclusions must be tested. The great doctrine of atoms and void stands or falls by it. The claims of reason and sense are thus adjusted. Instead of subordinating sense to reason, Epicurus is bound by the rules he lays down to subordinate reason to sense. Conflict between them is really impossible, for, reason being derived from sensation, all its conclusions are controlled, checked, and verified at every turn by sensation. Both, then, share in the making of knowledge. We see with the eye; we see also with the mind. The latter is no doubt the means to the knowledge of phenomena beyond the reach of sense. Only quantitative, not qualitative, difference, how ever, must be assumed between the two. The atoms which we mentally perceive we might conceivably actually perceive, if our senses were differently constituted. They are in no way different from sensible solids, except in minuteness, total absence of void, and consequent indivisibility. They are thus of a totally different order of reality from those objects which Plato believed the mind to cognise. Plato s ideas, as incorporeal, were for Epicurus non-existent.

We have now to give in outline, so far as we can in the words of Epicurus himself, his theory of the sensible world. Where it would conduce to clearness, we can supplement the master s teaching as laid down in the letter to Herodotus from the poem of Lucretius. The proposition from which we start is by no means peculiar to the ancient Atomists but had long been widely accepted. It amounts to an assertion of the indestructibility of primary matter. This implies that, when a particular thing comes into being, the imperishable elements of things, whatever they be, unite to form a new combination, and when this combination is dissolved and the elements, them selves imperishable, which have been temporarily united, again separate, the particular thing is destroyed. Empedocles and Anaxagoras indorsed the theory in this form as fully as the Atomists. Nor did Heraclitus surrender the principle when in his

doctrine of the perpetual flux of the sensible world he took the obvious step from being and not-being to the next category of becoming. What the proposition excludes is capricious, arbitrary, random agency; what it is feeling after and trying to ex press is orderly sequence in short, law in nature. "To begin with," says Epicurus, "nothing comes into being out of what is non-existent. For in that case anything would have arisen out of anything, standing in no need of its proper germs. And if that which disappears were destroyed and became non-existent, everything would have perished, there being nothing into which things could have been dissolved.[3]

Moreover, the sum total of things was always such as it is now and such it will ever remain. For there is nothing into which it can change. For outside the sum of things there is nothing which could enter into it and bring about the change. The terse summary of Lucretius, Ex nihilo nihil, in nthilum nil posse reverti, has passed into a proverb. Epicurus goes on to state succinctly what is the kernel of his whole doctrine. Not only do atoms and void exist, but atoms and void are all that exists. The whole of being, then, consists of bodies and space. The existence of bodies is everywhere at tested by sense, and it is upon sensation that reason must rely when it attempts to infer the unknown from the known. If there were no space, which we call also room, void, and intangible existence, bodies would have nothing in which to be and through which to move, as they are plainly seen to move. Beyond bodies and space there is nothing which by mental apprehension or on its analogy we can conceive to exist. Here we are speaking of wholes or separate things as distinct from their essential and accidental qualities. Of bodies, some are composite, others the elements of which these composite bodies are made. These elements are indivisible and un changeable; and necessarily se, if things are not all to be destroyed and pass into non-existence, but are to be strong enough to endure when the composite bodies are broken up, because they possess a solid nature, and are incapable of being anywhere or any how dissolved. It follows that the first beginnings must be indivisible, corporeal entities."[4]

The word here translated "indivisible" is identical with the word for "atom." Etymologically, "atom" means simply "indivisible thing," a thing which can not be cut in two. "Body," the reader must observe, is not unambiguous in Epicurus and Lucretius. Giussani s proposals for the

3 1 Letter to Herodotus, 38, Epicurea, p. 5, 1. 13 sqq. The letter to Herodotus is given by Diogenes Laertius, Book X, 35-83, and is reprinted in Usener, Epicurea, pp. 3-32. I follow throughout the text.

4 1 Letter to Herodotus, 39, Epicurea, p. 6, 5 sqq.

transposition of certain sections seem un convincing and are certainly confusing.

Properly speaking, atoms alone are bodies, for they alone of existent things have no admixture of void in them; but the term is extended to denote the composite things in which along with body proper, i.e. the atoms, there are also found interstices of void. All the things which we perceive by the senses belong to this class of composite bodies. To express atoms themselves, Lucretius uses a variety of terms, such as "elements," "first bodies," "first beginnings of things," sometimes even "seeds," or singly, "bodies," where the context renders the term unambiguous. What Epicurus means by essential and accidental qualities is well illustrated by Lucretius. "For whatever things are named, you will either find to be properties linked to these two things," viz., to bodies and void, "or you will see to be accidents of these things. That is a property," i.e., an essential quality, "which can in no case be disjoined and separated without utter destruction accompanying the severance, such as the weight of a stone, the heat of fire, the fluidity of water. Slavery, on the other hand, poverty and riches, liberty, war, concord, and all other things which may come and go while the nature of the thing remains unharmed, these we are wont, as it is right we should, to call accidents."[5] The subject will recur again in Epicurus.[6]

He now gives his reasons for believing the sum of things to be infinite. "The sum of things is infinite. For what is finite has an extremity, and the extremity of anything is discerned only by comparison with something else. Now the sum of things is not discerned by comparison with anything else; hence, since it has no extremity it has no limit, and since it has no limit it is unlimited or infinite. Moreover, the sum of things is infinite both by reason of the multitude of atoms and the extent of void. For, if void were infinite and bodies finite, the bodies would not have stayed anywhere, but would have been dispersed in their course through the infinite void, because they would not have met with anything which by coming into collision with them might support or check them. Again, if void were finite, the infinity of bodies would not have had anywhere to be."

Epicurus now describes his atoms, their shapes, and their incessant motion. The atoms, which have no void in them, out of which composite bodies arise and into which they are dissolved vary indefinitely in their shapes, for so many varieties of things as we see could never have arisen out of the recurrence of a definite number of the same shapes. The atoms

5 1 Lucretius, I, 449 sqq.

6 1 41, Epicurea, 7, 6 sqq.

of each shape are absolutely infinite, but the variety of shapes, though indefinitely great, is not absolutely infinite. The atoms are everlastingly in motion. Some of them rebound to a considerable distance from each other; other atoms merely oscillate when they have got entangled or are enclosed by a mass of other atoms shaped for entangling. This is be cause each atom is separated from the rest by void, which is incapable of offering any resistance to the rebound; while it is the solidity of the atom which makes it rebound after a collision, however short the distance to which it rebounds when it finds itself imprisoned in a mass of entangling atoms. Of all this there is no beginning, owing to the eternity of both atoms and void."[7]

The subject of the shapes of atoms is treated very fully by Lucretius. He begins thus: "Now mark, and next in order apprehend of what kind and how widely differing in their forms are the beginnings of all things, the atoms, "how varied by manifold diversities of shape; not that a scanty number are possessed of a like form instead of being few, the atoms of a like shape are infinite in number, as Lucretius subsequently proves; nevertheless all the atoms are not cast in a single mould; they have various shapes and sizes, "but because as a rule they do not all resemble one the other. And no wonder; for since there is so great a store of them that, as I have shown, there is no end or sum, they must sure enough not one and all be marked by an equal bulk and like shape, one with another."

By way of illustration he appeals to the fact that the subtle fire of lightning passes through openings through which earthly fire cannot pass. Hence he infers that lightning is composed of finer atoms. Light is transmitted through horn, which is impervious to rain. The atoms of light, then, must be finer than those of rain. Wine runs easily, oil slowly through a strainer: ergo, the atoms of oil are larger and more hooked than those of wine. Honey and milk are pleasant to the taste, wormwood and the like, nauseous; the former consist of smooth, the latter of jagged atoms, which tear a way into the body. And, generally, whatever affects the sense pleasantly or unpleasantly must be formed of atoms more or less smooth or rough, respectively. Again, some things with a bitter flavour have atoms not hooked but slightly prominent; those of fire and cold are jagged, but in different ways, as shown by touch. Those of stones, metals, and the like are hooked and branching, those of fluids smooth and round; those of smoke, mist, and flame, sharp but not tangled; while in sea-water round and rough atoms are mingled with round and smooth ones.

What Epicurus says about the motion of his atoms is not very clear.

7 42-44 Epicurea, 7, 17 sqq.

We may supplement it from Lucretius, whose account is as follows: "Sure enough no rest is given to first bodies throughout the unfathomable void, but driven on rather in ceaseless and varied motion they partly, after they have pressed together, rebound leaving great spaces between, while in part they are so dashed away after the stroke as to leave but small spaces between. And all which form a denser aggregation when brought together, and which rebound leaving trifling spaces between, held fast by their own close-tangled shapes these form enduring bases of stone and unyielding bodies of iron and the rest of their class, few in number, which travel onward along the great void. All the others spring far off and rebound far, leaving great spaces between; these furnish us with thin air and bright sunlight. And many more travel along the great void, which have been thrown off from the unions of things or, though admitted to such unions, have yet in no case been able likewise to assimilate their motions.

The drift seems to be that we can imagine three conditions in which atoms find themselves: (1) free atoms, moving singly in space before and after collision; (2) atoms, once free, which after collision are entangled or interlaced, owing to difference of shape, with other atoms. When a shell of such entangled atoms has been formed, it may enclose (3) imprisoned atoms, only partially free, colliding with each other, but only rebounding to short distances because they cannot escape from the network of the entangled mass or shell within which they are confined. The difference between (2) and (3) can be illustrated from the physical constitution of sensible bodies, all of which, as seen above, are composite, having interstices of void between their constituent atoms. In gases the atmosphere is the most familiar case and probably also in liquids, the cohesion of the parts is imperfect, and the system formed by the constituent atoms requires, if it is to maintain even this imperfect cohesion, to be enclosed within definite bounds. Otherwise their constituent atoms, so imperfectly do they cohere, always tend to disperse and become once more free. The only bounds which we can imagine in the case of the air are the "flaming walls" of our world. For liquids these bounds are the sides of the vessel containing them. The case is different with the great majority of composite bodies commonly denoted as solid, metals, stones, etc., the component atoms of which have become so closely entangled that they are not easily separated. The degree of cohesion, then, depends upon the closeness of the entanglement, and this in the last resort upon the shape of the atoms. There is one point on which more information would have been welcome. When, in consequence of collision, atoms have become entangled or interlaced, what is the exact nature of their motion? All the

atoms, we are told, are everlastingly in motion; but there are no details to show how precisely the motion of two or more entangled atoms such, for instance, as these differs from the motion of a single free or unimprisoned atom. In the densest substance known, so long as they are composite bodies there are interstices of void. Even the atoms in a piece of steel are everlastingly in motion, throbbing, palpitating, oscillating so far as the interstices of void allow. The narrower the interstices and the shorter the path which the atom describes, since its velocity is uniform, the more often must it retrace it. In the case of composite bodies, the motion of translation is evident to the senses. When a cannon ball is shot into the air every one of its atoms executes the trajectory motion. But when it has fallen to the ground its atoms are still moving with uniform velocity, throbbing and oscillating as before over the tiny interstices of void within the cannon ball, but then their motions are wholly internal, latent (motusintestini, cl an de stint). Nor can we suppose that these internal motions cease during its flight through the air. Here a simile may help us. A swarm of bees moves from tree to tree. Seen from a distance, their motion is a simple one, a motion of translation, immeasurably slower but still of the same nature as the flight of a cannon ball. A nearer view discloses each separate bee executing motions in all manner of directions, upward, downward, to right, to left, backward, forward. This it continues to do during the flight precisely as it had done when the swarm as a whole was at rest, but in such a way that each bee in the entire swarm makes the transit from the one tree to the other. The direction of the motion is altered, not the motion itself. As the flight of the single bee in the swarm to the flight of die whole swarm, so is the invisible motion of a single atom in a composite body to the visible motion of the whole body. Or take the example of Lucretius, the particles of dust seen in a sunbeam through a hole in a shutter. "Observe whenever the rays are let in and pour the sunlight through the dark chambers of houses: you will see many minute bodies in many ways through the apparent void mingle in the midst of the light of the rays, and as in never-ending conflict skirmish and give battle, combating in troops and never halting, driven about in frequent meetings and partings; so that you may guess from this what it is for first beginnings of things to be ever tossing about in the great void. So far as it goes, a small thing may give an illustration of great things and put you on the track of knowledge. And for this reason, too, it is meet that you should give greater heed to those bodies which are seen to tumble about in the sun s rays, because such tumblings imply that motions also of matter latent and unseen are at the bottom. For you will observe many things there impelled by unseen blows to change their

course, and driven back to return the way they came, now this way, now that way, in all directions round. All, you are to know, derive this restlessness from the first beginnings,"[8] i.e., the atoms. "For the atoms move first of themselves; next, those bodies which form a small aggregate and come nearest, so to say, to the powers of the atoms, are impelled and set in movement by the unseen strokes of those atoms, and they, next in turn, stir up bodies which are a little larger. Thus motion mounts up from the atoms, and step by step issues forth to our senses, so that those bodies also move, which we can discern in the sunlight, though it is not clearly seen by what blows they so act." 2 So complicated, then, is the process by which the motion of single, free atoms ascends by various shifting stages, hard to discriminate, and gives rise to the motion of atoms in groups, larger or smaller, more or less closely associated, from mobile are to the toughest flint or steel.After thus dealing with the motion of the atoms, Epicurus in the letter to Herodotus next passes abruptly to the infinite worlds whose formation is due to this motion. "There is an infinite number of worlds, some like this world, others unlike it. For the atoms, being infinite in number, as has just been proved, are borne ever further in their course. For the atoms out of which a world might arise or by which a world might be formed have not all been expended upon one world or a finite number of worlds, whether like or unlike this one. Hence there will be nothing to hinder an infinity of worlds."[9]

What he means by a "world" he explains elsewhere. "A world is a circumscribed portion of the universe which contains stars and earth and all other visible things." He adds that it is cut off from the infinite and the circumscribing limit in which it ends, its outside boundary, may revolve or be at rest, and may be rounded, triangular, or of any other shape. In our world, so Epicurus thinks, the central earth plays the most important part, being vastly greater in size and mass than the sun and stars which surround it. This fundamental error arose from his refusal to treat astronomy as a serious or exact science, to which reference has already been made. The result is curious. If we neglect the miniature sun and flickering stars which the eye of sense perceives surrounding the earth in this our world, the bound less universe which Epicurus descries with his mental vision approximates to a far greater degree than we might at first sight suppose to the universe as it is conceived by the modern astronomer. To the latter the universe is resolved into countless suns, each with its attendant planetary system, and the nebulae out of which such solar systems are believed to have developed. For him the many suns and

8 II, 114 sqq- a H, 133 sq.

9 Epicurea, 9, 4 sqq.

planetary systems are dotted here and there throughout space, as were the "worlds" of Epicurus. And yet of the "solar"[10] as distinct from the "sidereal" system the account given by Epicurus is flagrantly inadequate, and even puerile, not merely when judged from a modern stand-point, but even when compared with the current notions of the astronomers of his day.

The next division of the subject is concerned with the manner in which we are affected by external objects, and we begin with a remarkable hypothesis, that from the exterior surfaces of all composite bodies there is a perpetual emission of particles of matter or what we may call "films." "There are outlines, or films which are of the same shape as the solid bodies, but their fineness far exceeds that of any objects that we see. For it is not impossible that there should be found in the surrounding air emanations of this kind, materials adapted for expressing the hollowness and smoothness of surfaces, and effluxes preserving the same relative position and sequence which they had in the solid objects. To these films we give the name of images or idols."[11]This doctrine of emission or efflux can be traced back to Empedocles and Democritus. To the first inquirers at the threshold of psychology the problem of sense-perception was mainly physiological or rather frankly physical. The act of perception was assimilated to the commonest cases of action and reaction between external things, as when a stone strikes the water or a seal is impressed on wax. Bodies so acting and reacting were observed to be in contact, and this fitted the senses of touch and taste. But colours, sounds, and smells are perceived at a distance. The problem was: How is this action at a distance to be explained? Not much help could be obtained from the very crude notion of attraction expressed in the proverb "Like to like," although it plays a large part both in the theory of knowledge and the theory of vision set forth by Empedocles. Both he and Democritus were driven to assume that, as in the case of touch, there must somehow be con tact even to allow of like acting upon like. Under the stress of such necessities of thought they took refuge in the theory of emanations. Vision was the sense chiefly studied. Moreover, there was the concrete fact that an image of the object seen may be observed in the pupil of the eye. Certain other experimental facts, the losses of substance caused by evaporation and corrosion, the way in which even hard stones imperceptibly crumble and wear away beneath the tread, may have contributed, as well as the evidence of that perpetual change in the physical

10 Or, if the expression be preferred, the "planetary" system: that made up of our sun and its attendant planets.

11 Epicurea, p. 9, 12 sqq.

universe which so powerfully impressed Heraclitus. By whatever steps it was reached, this astounding assumption was made the basis of the Atomists theory, not only of perception, but also of thought. For when once it is granted that emanations are given off by objects, it is comparatively easy to make the further assumption that some of these emanations are too fine to act upon the sense-organs, but not too fine to affect the equally material soul or mind. For the term "film" which we have used might equally well be substituted "efflux," "husk," "filament," "layer," or even " membrane." We know that Democritus called them Deikela, a term which, like "idols," suggests likeness. The outside layer or film, as Epicurus is at pains to explain, may resemble the solid body from which it has parted in the mutual relation and inter-connection of its various parts, that is to say, in the two dimensions which a surface has in common with a solid. The all-important distinction between them is in the third dimension of depth. The film lacks depth. In stereoscopic slides this impression of depth is successfully imitated, and Epicurus, probably following Democritus, supposes a constant succession of films from the same object to be the means by which the impression of solidity is, in fact, conveyed to the eye.

It is obvious that the theory raises more difficulties than it solves. What becomes of all the films? Again, all solid bodies must be perpetually suffering loss. How is this loss made good? As to the last point, either we are referred to the enormous quantity of free atoms everywhere travelling in the void, which by their accession may be supposed to make these losses good, or we are reminded that all composite wholes are frail and perishable, and do as a fact, in the course of time, suffer diminution before they are finally dissolved. The modern reader hardly needs to be reminded how utterly inadequate to its special purpose this assumption was, and how enormous the work that had to be done by the sciences of anatomy, physiology, and optics before the conditions under which an object is seen could be understood. The Greeks knew nothing of the retina or the refractive properties of the crystalline lens, and had no idea of the eye as an optical instrument, of the nature of light or of the nerves. The knowledge we have, imperfect as it is, on these subjects has been acquired after painful efforts and strenuous researches carried on for generations. It would have been impossible with out the microscope, and the continuance of those endeavours to systematise and extend knowledge for its own sake, which Epicurus discouraged on principle. Why should men busy themselves with minute investigations of the structure of the eye and the laws of reflection, so long as there were infinite atoms, enough and to spare, to bring a specimen of every visible object to the

eye of every observer? Besides, an ingenious corollary provides an easy explanation of erroneous perceptions, hallucinations, and dreams. Not only may films from real objects become distorted and blunted, but films from different objects, or even casual atoms, may meet in the air, blend, and enter the eye, causing the vision of objects which never were on land or sea, both in our waking hours and in dreams. Such aggregates or complexes of atoms, taking on the delusive appearance of real objects, were technically designated Systaseis.

Epicurus goes on: "So long as nothing comes in the way to offer resistance, motion through the void accomplishes any imaginable distance in an indefinitely short time. For resistance encountered is the equivalent of slowness, its absence the equivalent of speed. Not that, if we consider the times perceptible by reason alone, the moving body arrives at more than one place simultaneously (for this, too, is inconceivable), nor that when in time perceptible to sense it arrives from any point you please of the infinite, it will not be starting from the point to which we conceive it to have made its journey. For, if it stopped there on its arrival, this would be equivalent to its meeting with resistance, even if up to that point we allow the speed of its journey to imply the absence of resistance."

The reader will note that Epicurus is talking about films, and the enormous velocity with which they must travel in order to reach us, as in his view they appear to do, instantaneously. This, however, in no way detracts from the importance of these almost parenthetical remarks about motion; not the motion of atoms, which is at all times uniform, but the motion of systems of atoms. What is here said applies to all such systems, whether the union is loose and easily broken, as is the case with an invisible film, more close as with the air and other gases, closer still as in water and other fluids, or comparatively permanent and durable as in earth and the various composite bodies which we call solid. In all cases alike the system moves slowly if resistance is encountered, either externally from the medium, air or water, or internally and this is far more important from the jostling, collision, and backward rebound of the single atoms composing the system. Such internal resistance tends to impede the system. So, also, would the pause of rest, if the system reached a point, stopped, and then went on. But this, he ex plains, the film does not do unless it encounters resistance.

He continues: "This is an elementary fact which in itself is worth bearing in mind. In the next place, the exceeding fineness of the images is contradicted by none of the facts under our observation. Hence, also, their velocities are enormous, since they always find a void passage to fit them. Besides, owing to their infinitesimal fineness, they meet with

no resistance or very little, though many structures, even if they be of infinitesimal fineness, do at once encounter resistence."

The sun's heat is the example given by Lucretius. He says: "First of all we may very often observe that things which are light and made up of minute atoms are swift. Of this kind are the light of the sun and its heat." But, swift as they are, both light and heat are often obstructed. So Lucretius in another passage: "But that heat which the sun emits and that bright light pass not through empty void; and therefore they are forced to travel more slowly, until they cleave through the waves, so to speak, of air. Nor do the several minute atoms of heat pass on one by one, but closely entangled and massed together; whereby at one and the same time they are pulled back by one another and are impeded from without, so that they are forced to travel more slowly." Here resistance, both from without and within, would seem to be very clearly indicated.

But to return to Epicurus. "The production of the images is as quick as thought. For particles are continually streaming off from the surface of bodies, though no diminution of the bodies is perceptible because other particles take their place. And those given off for a long time retain the position and arrangement which their atoms had when they formed part of the solid bodies, although occasionally they are thrown into confusion. Sometimes such films are formed very rapidly in the air, because they need not have any solid content, and there are other modes of their formation. For there is nothing in all this which is contradicted by sensation, if we look at the clear evidence of sense in order, in some degree, to learn what vehicles will transfer to ourselves the mutual inter-connection of external objects.[12]"We must also consider that it is by the entrance of something coming from external objects that we see their shapes and think of them. For external things would not have stamped on us their own nature of colour and form through the medium of the air which is between them and us, or by means of rays of light or currents of any sort going from us to them, so well as by the entrance into our eyes or minds of certain films coming from the things."[13]

Here two theories of vision are criticised. Democritus, though it was from him that Epicurus bor rowed his doctrine of films, appears to have combined with it the view that the air is the medium by which visual impressions reach the eye. Possibly Gomperz is right in supposing that Democritus conceived the films or husks themselves entering the eye to account for vision of near objects only, and introduced air as the medium for visual impressions of objects at a greater distance. One remark of his

12 Empedocles, Fragment 84, Diels. 2

13 Plato, Timceus, 45B-46A.

has come down to us to the effect that, if it were not for the intervening air, we should clearly descry even minute objects at a great distance, such as an ant crawling along the sky. At any rate, he supposed, so we are told by Theophrastus, that the air received impressions from the objects of sight and transferred them to our organs of vision, such impressions being literally stamped on the air, like the mark of a signet on wax. It was owing to this transference that they were often blurred and indistinct when they reached us.

The second theory rejected, that of Plato in the Timceus is commonly held to have originated with Empedocles, who certainly compared the structure of the eye to a lantern. The gist of his comparison is that as the fire within the lantern, screened from the winds by transparent sides of horn, talc, or linen, nevertheless "leaps forth and casts a gleam through the surrounding darkness," so visual rays of the nature of fire dart out or shine forth from the pupil of the eye. Plato s account of vision is more complicated; it involves the co-operation of three "fires," (1) that which streams forth from the eye (the visual current), (2) the fire of daylight in the air, and (3) the fire which is the colour of the object seen. Vision takes place when these three coalesce. 2 Both Empedocles and Plato held that like is known by like. "We see fire," says the former, "by the fire that is in us." Epicurus sticks to the film as a simple and sufficient expedient and will have no medium like air. His films travel along interstices of void through the air, and he will not hear of rays emitted from the eye to meet the films.

Our text continues: "These films or outlines are of the same colour and shape as the external things themselves, in spite of the difference in size; they move with rapid motion and this again explains why they present the appearance of the single continuous object and retain, when they impinge upon the sense, the mutual inter-connection which they had in the object, such impact being due to the oscillation of the atoms in the interior of the solid object from which they come. And whatever presentation we derive by direct contact, whether with the mind or with the sense-organs, be it shape that is presented or properties, this shape as presented is the shape of the solid thing, and it is produced by a frequent repetition of the image or by the trace of itself which it leaves behind it. In sensation an image strikes upon the sense-organ. In every act of pre-conception or of memory an image strikes the mind. A series of repeated images or the traces which they leave behind them in us produce a presentation of the shape or properties of the external object from which they came. And if the presentation be obtained in this way by direct con tact, whether on the senses or the mind, it corresponds exactly in shape

and properties with the external object. If these conditions are fulfilled, the shape as presented to us in sensation and memory or in pre conception is the real shape of the object, the properties so presented are the very properties which the external object has. Epicurus is here passing from the subject of films in general to the veracity of the reports of the senses. A theory of mediate perception must answer the question: How do I know that what I receive through the medium is an exact copy of the object ?

He continues: "Falsehood and error always depend upon the intrusion of opinion when a fact awaits confirmation or the absence of contradiction, which fact is afterwards frequently not confirmed or even contradicted. For the presentations which are received, e. g., in a picture, or arise in dreams, or from any other form of apprehension by the mind or by the other criteria of truth would never have resembled what we call the real and true things, had it not been for the impact upon us of certain actual things of the kind. Error would not have occurred if we had not experienced some other movement in ourselves, conjoined with, but distinct from, the perception of what is presented. And from this movement, if it be not confirmed or be contradicted, falsehood results; while, if it be confirmed or not contradicted, truth results. And to this view we must adhere if we are not to repudiate the criteria founded on the clear evidence of sense, nor again to throw all things into confusion by supporting false hood as if it were truth."[14]

The foregoing account is now applied to hearing and smelling. "Again, hearing takes place when a current passes from the object, whether person or thing, which emits voice or sound or noise, or produces the sensation of hearing in any way whatever. This current is broken up into homogeneous particles which at the same time preserve a certain mutual connection and a distinctive unity extending to the object which emitted them and thus cause the perception of it or, if not, merely indicate the presence of the external object. For without the transmission from the object of a certain inter-connection of the parts, no such sensation would have arisen. There fore we must not suppose that the air itself is moulded into shape by the voice emitted or by similar sounds; for it is very far from being the case that the air is acted upon in this way. The blow which is struck in us when we utter a sound causes such a displacement of the particles as serves to produce a current resembling breath, and this displacement gives rise.

The Greek word Pneuma means both breath and wind. Here the current or stream of voice-atoms is most probably compared to breath itself

14 50, 52, I. c., p. 12, 10 sqq.

issuing from the lips. It is, however, just possible that it is com pared to wind, for the same word Pneuma, when it denotes a constituent of that mixed substance, the soul, is translated by Lucretius ventus, and must therefore denote wind, especially as air, strangely distinguished from wind, is another constituent of the soul. Again, we must believe that the sense of smelling, like that of hearing, would produce no sensation were there not particles conveyed from the object which are of the proper size for exciting the organ of smelling, some of one sort, some of another, some exciting it confusedly and strangely, others quietly and agreeably. The ordinary view made air the medium by which sound, conceived as a shock or blow of one thing upon another, was conveyed to the ear. Thus Empedocles held that particles of air were given off by the sonant body. Hearing, according to him, is caused by the impact of the air-wave against the cartilage or bony flesh which is suspended within the ear, oscillating as it is struck like a gong. As the organ of vision contains a lantern, so the organ of hearing contains a bell or gong, which the sound from without causes to ring. But the Atomists, to whom the air was not, as it was to Empedocles, a form of primary matter, but simply one of the composite bodies, were de barred from regarding the emanation from the sonant body as consisting of air. What is given off, i.e., sound, considered as a physical thing, is a stream of atoms. At the same time Democritus would not altogether abandon the common belief that air is the medium by which we hear. His view, then, is a kind of compromise. The emanation, i.e., the stream of atoms, from the resonant body sets in motion the air which lies before it. In this stream of atoms from the body and in the air which is moved by it like atoms come together according to the similarity of their shapes and sizes. The sensation of hearing occurs when the atoms of air, rolled along by and with the atoms of vocal sound, reach the orifice of the ear. It will be seen that Epicurus is resolved to be perfectly consistent and excludes* the agency of the air altogether, either as medium or emanation. The medium is the void, the particles of sound conveyed are atoms of that which is sonant. On this view we hear exactly as we smell, except that atoms of sound enter the ear, atoms of scent the nostril.

Atoms, then, streams of atoms emitted from the surface of composite bodies, are the causes of our perceptions of external things. The things perceived have colour, sound, and odour. Is this so with the atoms? Epicurus proceeds: “We must hold that the atoms possess none of the qualities belonging to things which come under our observation except shape, weight, and size, and the properties necessarily conjoined with shape. For every quality changes, but the atoms do not change, since, when

the composite bodies are dissolved, there must needs be a permanent something, solid and indissoluble, left behind, which makes changes possible: not changes into the non-existent nor out of the non-existent, but through differences of arrangement and some times through additions and subtractions of the atoms. Hence these somethings capable of being differently arranged must be indestructible, exempt from change, but possessed each of its own distinctive mass and configuration. This must be assumed. For in the case of changes of configuration within our experience, the figure is supposed to be inherent when other qualities are stripped off, but the qualities are not supposed, like the shape, which is left behind, to inhere in the subject of change, but to vanish altogether from the whole body. Thus, then, what is left behind is sufficient to account for the differences in composite bodies, since something must necessarily be left instead of everything being annihilated."

The atom is unchangeable ex hypothesi, and this may be secured provided that the qualities which the atom possesses are themselves unchangeable. So long as the shape remains unaltered through all the motions, collisions, and entanglements which befall the atom, since there is no void within it, there will be no alteration in size and, since weight depends upon size or mass, there will be no alteration in weight. In this way size and weight may be regarded as properties necessarily conjoined with shape. Neither of them would be affected by different arrangement or position of the atoms, on which ultimately depend the qualities which composite bodies have and atoms have not. Take colour. In a composite body or aggregate of atoms differently placed and arranged and, it may be, themselves different in shape and size, the colour which we perceive as belonging to this aggregate, and which by the canon of Epicurus really does belong to it, is a con sequence of these same atomic positions, arrangements, shapes, and motions, and a change in them may change the colour of the thing or composite body without that thing necessarily ceasing to be what it was. The question may be asked: To which division of qualities does colour belong ? Is it a property, a coniunctum? Or is it an accident, an eventum? It seems safest to reply that generic colour, colour of some sort or other, is a property of all visible things, so long as they are visible; but particular colour is an accident or eventum of a particular visible thing, which often changes like the hues of a sunset cloud or in a peacock s tail, owing to the difference of atomic motions produced by light or some other external influence; lastly, that when a body ceases to be visible it has no colour. The qualities which are not inherent are accidental qualities, eventa, such as whiteness, triangularity, which a thing may gain or lose without ceasing to be what it is. Figure

or shape in general, however, is not such an eventum, but an essential property, or coniunctum, of all material things whether visible or not. We regard shape as something which a material thing must have as long as it exists at all. We recognise that the shape changes, but we still think of the thing as being the same under an altered shape, as in the growth of animals and plants or when the same block of wax is moulded into different shapes. In other words, so long as a material thing persists it must have some shape or other.

Again, "we should not suppose that the atoms have any and every size lest we be contradicted by facts; but alternations of size must be admitted, for this addition renders the facts of feeling and sensation easier of explanation. But to attribute any and every magnitude to the atoms does not help to ex plain the difference of quality in things; moreover, in that case atoms large enough to be seen ought to have reached us, which is never observed to occur; nor can we conceive how its occurrence should be possible." This is another correction of Democritus, who imposed no limitations on the size of atoms, arguing that, for all we know, they might be as large as you please somewhere in an infinite universe. "We must not suppose that there is an infinity of particles in any finite body. Hence, not only must we reject as impossible subdivision ad infinitum into smaller and smaller parts, lest nothing be left strong enough to form new aggregates and the things that exist be necessarily pulverised and annihilated, but in dealing with finite things we must also reject as impossible the progression ad infinitum by less and less increments."

The notion of such a progression is the groundwork of the famous puzzle of Achilles and the tortoise, propounded by the Eleatic Zeno. Achilles, who runs ten times as fast as the tortoise, gives the latter a start of a metre. When Achilles has run one metre the tortoise is one decimetre in advance; when Achilles has got as far as this he finds the tortoise a millimetre in advance, and so on ad infinitum; whence Zeno wished it to be inferred that Achilles will never overtake the tortoise. Epicurus simply denies the possibility of continuing ad infinitum such a progression-formed by a series of increments, each term in the series being a definite fraction of the preceding term, precisely as he denies the possibility of continuing ad infinitum the process of subdivision of a finite body, e.g., by taking half, then the half of this half, or one-quarter, next the half of this quarter, or one- eighth, and so on. The latter series of fractional divisions is the complement of the former, that of fractional increments. The impossibility in the one case and in the other is bound up with Epicurus s assumption that in the last resort not only body, i.e. matter, but the dimensions of body, which are conceived as traversed in motion,

are discrete. To the atom, the indivisible minimum of body, corresponds an indivisible minimum of a dimension, of spatial dimensions, length, breadth, and depth, at any rate when the space is filled and occupied with body, under which conditions alone we have the clear evidence of sense and intellect for progression from point to point upon it. "For, when once we have said that an infinite number of particles, of whatever size, are contained in anything, it is not possible to conceive how this should be. How, in the first place, could the magnitude which they form be any longer finite? For clearly our infinite number of particles must have some definite size, and then, of whatever size they were, the aggregate they made would be infinite. And in the next place, since what is finite has an extremity which is distinguishable, even if it is not by itself observable, it is not possible to avoid thinking of another such extremity next to this. Nor can we help thinking that in this way, by proceeding forward from one to the next in order, by such a progression we can arrive in thought at infinity."

Atoms of any and every size are here disproved on other grounds than the foregoing. The polemical reference is to Anaxagoras, who maintained an in finite number of infinitesimal "seeds," in his own words, "infinite, both in number and in smallness, for the small, too, was infinite." 2 Moreover, they are all present, Anaxagoras held, in every finite thing. The possibility of a minimum he denied, being on this point at issue with Leucippus and Democritus, the Atomist predecessors of Epicurus. Let us give the very words of Anaxagoras: "Nor is there a least of what is small, but there is always a smaller; for it is impossible that what is should cease to be by being divided." 3 And, since the portions of the great and of the small are equal in amount, for this reason, too, all things will be in everything. Nor is it possible for them to be apart, but all things have a portion of everything. And in all things many things are contained and an equal number both in the greater and in the smaller of the things that have separate existence."[15]

Epicurus takes the doctrine to imply that the number of atoms in each thing is infinite, and he objects that, however small in size the individual atoms, an infinite number of them could produce a body not finite but infinite. His second objection is that, if the atoms be of finite size and an infinite number of them be contained in a single thing, the progression from the extremity of the first to the extremity of the next, and so on to that of the last, would be a never-ending progress, which he has before declared to be impossible. The word trans lated here "extremity" and in Lucretius "cacumen" will best be understood if we take an angular point

15 Fragment 6, Diels 2

or projection or extreme edge on any sensible body of finite size, e.g., the "point" of a sharpened lead- pencil or the corner of a cube. If each atom has a certain shape it must be conceived on the analogy of finite bodies to project some part of this shape which the mental vision can distinguish. But what, it may be asked, of spherical atoms? As it is impossible to see the whole of a finite sphere with the bodily eye or to present to the eye of the mind the whole of a spherical atom at once, the part which we do see will be bounded. The outside or edge in the part we do see is in this case the extremity projecting into view. This applies to the visualised pictorial image as well as to actual perception.

Before we go further into the thorny subject of discrete minima of area or surface, of length and other dimensions, whether of body or space, the modern student of philosophy will do well to remember where he stands at present. He is familiar with two doctrines of space,[16] the Kantian and Berkeleian. The former is not free from contradictions; it involves the idea of infinite divisibility in the space- world of our experience. The Berkeleian denies this infinite divisibility. We experience only an aggregate of minima dwisibilia; no line is infinitely divisible. Zeno s problem of motion from one point to another, the moving body having to pass through an infinite number of points in the interval, does not exist for Berkeley any more than for Epicurus; the movement is through a discrete number of units of length. But Berkeley allowed for all manner of substituting in our construction of the world. One experience can stand for and symbolise another. Hence by substituting for the least part of the line perceived or minimum divisibile, its magnified representation as seen under a microscope, we treat that as the same line, and this we can divide, and this process can be repeated in thought indefinitely. The mathematician generalises our experience and gives us a conceptualised mathematical space which is infinitely divisible and without limits in extent. Berkeley s procedure furnishes an illustration and a clue to that of Epicurus. Over and over again we find the latter stating that the mental vision must be substituted for actual perception with the eye; that where direct observation is impossible we must visualise in thought. His conclusions, as we shall see, are very similar to Berkeley's, but we must not overlook one great difference between them. Berkeley's doctrine is phenomenological, that of Epicurus is ontological. For him the discrete minima have absolute existence.

Epicurus continues: "We must consider the minimum perceptible by sense as not corresponding to the extended which is capable of being tra-

16 Cf. G. S. Fullerton, A System of Metaphysics, cc. X-XII, where the two doctrines are expounded and compared.

versed, nor again as utterly unlike it, but as having something in common with the extended things capable of being traversed, though it is without distinction of parts. But when, from the resemblance of what they have in common, we think we shall distinguish something in the minimum, one part on one side and another part on the other side, another minimum equal to the first must catch our eye. In fact, we see these minima one after the other, beginning with the first, and not as occupying the same space; nor do we see them touch each other with their parts, but we see that they afford a means of measuring magnitudes by force of their individuality: there are more of them if the magnitude measured is greater, fewer of them if the magnitude measured is less."[17] The magnitude measured by visible minima would naturally be area or surface. It appears, then, that Epicurus conceives a finite surface as reducible in the last resort to an assemblage of discretes which he terms sensible minima, and declares to be units of measurement. Now compare the mathematical conception of a finite surface. The geometer s surface contains an infinite number of lines, each line continuous but infinitely divisible, each division of a line being a point. Epicurus, on the contrary, holds that the finite area or surface consists of a finite number of discontinuous units of area, minima which are discontinuous and discrete.Hitherto we have been dealing with sensible things, with sensible minima, whether of surface or mass. Thus in the diagram the smaller square may be regarded as presenting four minima, the larger square nine.

Epicurus now proceeds to apply his conclusions to the atom. "We must think that the minimum in the atom behaves conformably to this analogy. It is only in minuteness that it differs from the minimum seen by sense, but it follows the same analogy. We have already declared on the analogy of things within our experience that the atom has magnitude, and herein we have merely reproduced something small on a larger scale. And, further, the least and simplest of lengths must be regarded as boundary-points, furnishing from themselves as units the means of measuring lengths, whether greater or less, the mental vision being employed, since direct observation is impossible. For the community which subsists be tween them, boundary-points of length, and the things without extension or incapable of being traversed, i.e. the minimal parts of area or surface, is sufficient to justify the conclusion so far as this goes. That is, as the visible minima measure area or surface, so the boundary-points or discrete minima of length measure lengths. This passage clearly shows that Epicurus regarded a line or length as made up of certain minima of length, his substitute for the geometrical point. Geometers

17 Epicurea, p. 17, i-n.

denied that a line could be conceived as made up of, or could be resolved into, a series of points. But in their conception and definition of a point they differed widely from Epicurus. The geometers assumed infinite di visibility; there was a point wherever the line could be divided. Epicurus introduces us to discrete minima of length which bound finite perceptible lengths precisely as the geometer s points bound his lines. The validity of the geometrical point had been al ready questioned by others; even Plato, it is said, proposed to substitute the expressions "beginning of a line" or "indivisible line" for point.[18]

This by the way. Epicurus now returns to the minima of the atom. "But it is not possible that these minima of the atom should group themselves together through the possession of motion"; in other words, these minima cannot first exist apart and then, in virtue of possessing the attribute of motion, unite together to form the atom. Our pressing business now is with the atom conceived on the analogy of finite bodies as occupying space and therefore extended, and, being extended (or, as Epicurus prefers to say, "capable of being traversed"), as having parts. We must not by one whit modify the conception of the atom as indestructible, immutable, impenetrable matter. It has parts, but it has no interstices of void; therefore no destroying agency can get between these parts and sever them. Hence we must recognise that, though the conception of atoms accounts for all composite bodies, analysis is not exhausted when these composite bodies have been reduced to atoms. There is a minimum smaller than the atom, but no such minimum separately exists. The atom is the least thing which can exist "in solid singleness," the limit of separate, individual existence. It would therefore be an error to suppose that minima of the atom exist at first apart and then combine to form atoms as atoms combine to form composite things. The minima of the atom are in separable from each other and from the atom to all eternity.

In the following passage Lucretius reproduces his master s doctrine on this point: "Then again, since there is ever an extremity, a bounding point (to bodies which appear to us to be a least, there ought in the same way to be a bounding point the least conceivable)[19] to that atom which already is beyond what our senses can perceive: that point sure enough is without parts and consists of a least nature and never has existed apart by itself, and will not be able in future so to exist, since it is in itself part of that other; and so a first and single part and then other and other

18 Aristotle, Metaphysica, A, 9, 992, a, 19-23.

19 A couple of lines must have dropped out between 599 and 600 of our present text of Lucretius. Munro fills the gap with the words en closed in square brackets, and thus renders the argument and general sense perfectly clear.

similar parts in succession fill up in close serried mass the nature of the atom; and since these cannot exist by themselves, they must cleave to that from which they cannot in any way be torn. Atoms, therefore, are of solid singleness, massed together and cohering closely by means of least parts, not compounded out of a union of those parts, but rather strong in everlasting singleness. From them nature allows nothing to be torn, nothing further to be worn away, reserving them as seeds for things. Again, unless there shall be a least, the very smallest bodies will consist of infinite parts, inasmuch as the half of the half will always have a half and nothing will set bounds to the division. Therefore, between the sum of things and the least of things, what difference will there be? There will be no distinction at all; for how absolutely infinite soever the whole sum is, yet the things which are smallest will equally consist of infinite parts. Now, since on this head true reason protests and denies that the mind can believe it, you must yield and admit that there exist such things as are possessed of no parts and are of a least nature. And since these exist, those atoms also you must admit to be solid and everlasting."[20] If you reject infinite subdivision you must admit the existence of minima (though not necessarily their separate existence). "Once more, if Nature, creatress of things, had been wont to compel all things to be broken up into least parts, then, too, she would be unable to reproduce anything out of those parts, because those things which are enriched with no parts cannot have the properties which be getting matter ought to have I mean the various entanglements, weights, blows, clashings, motions by means of which things severally go on." In other words, why, it may be objected, should we stop short at atoms? Why should not the minimum replace the atom as the ultimate unit? The answer is that, because the minimum is supposed to have no parts, it is impossible to conceive it to behave as the atom does. It cannot become entangled, collide, fall, or move in the same way as does the atom which is possessed of parts.

Hitherto the incessant motion of atoms has beenpostulated and two of its species, (1) vibration or oscillation of the imprisoned atom and (2) rebound to a greater distance of the unimprisoned atom, have been mentioned, both species implying previous col lision. There is another kind of atomic motion. Atoms have weight and, like all heavy bodies perceived by sense, tend to fall downward, i.e., to move in a certain empirically determined direction. In the summary of Epicurean doctrine which we have chosen as our principal authority this downward tendency of the atom is not explicitly stated, though a passage with which we shall shortly deal clearly distinguishes motion due to weight from mo-

20 1, 599 sqq. 2 I, 628 sqq.

tion due to collision, and the paragraph next to be cited is unintelligible, except on the assumption that Epicurus held the doctrine in question. As a necessary introduction we will cite the account given by Lucretius: "Since they travel about through void, the atoms must all move on either by their own weight or haply by the stroke of another. For when during motion they have, as often happens, met and clashed, the result is a sudden rebounding in an opposite direction; and no wonder, since they are most hard and of weight proportioned to their solidity and nothing behind gets in their way." All atoms and all bodies compounded of atoms have a downward tendency. But, as this direction is liable to alteration in consequence of collision, we must add, "unless some force acting upon them, some blow, compel them to move laterally or even vertically upward." As sense-perception is the foundation of knowledge, especial care is needed here, for fire and vapour are seen to rise, not fall. As Lucretius says: "Now methinks is the place herein to prove this point also that no bodily thing can by its own power be borne upward and travel upward; that the bodies of flames may not in this matter lead you into error. For they are begotten with an upward tendency and in the same direction receive increase; and goodly crops and trees grow upward, though their weights, so far as in them is, all tend downward. And when fires leap to the roofs of houses and with swift flame lick up rafters and beams, we are not to suppose that they do so spontaneously without a force pushing them up. See you not, too, with what force the liquid of water spits out logs and beams? The more deeply we have pushed them sheer down and have pressed them in, many of us together with all our might and much painful effort, with the greater avidity it vomits them up and casts them forth so that they rise and start out more than half their length. And yet me- thinks we doubt not that these, so far as in them is, are all borne downward through the empty void. In the same way flames also ought to be able, when squeezed out, to mount upward through the air, al though their weights, so far as in them is, strive to draw them down." Meteors, lightnings, the sun s light and heat are also adduced to illustrate the universal tendency of bodies to fall.

To return to Epicurus: "In that which is infinite we must not say that there is an up and down in the sense of an uppermost or a nethermost point. Still, a line may be drawn vertically upward and stretch to infinity from the point, wherever it is, where we stand, and we must not say that this distinction of up and down will never be found in it. Nor, again, must we say that, in respect of any point we think of, that which is beneath it and extends to infinity is at once above and beneath as regards that same point. For this is inconceivable. Hence we can assume one motion in an

upward direction, and only one, which we extend in thought to infinity, and one motion in a downward direction, and only one, even if ten thousand times over it happens that that which moves to the regions above our heads encounters the feet of those above us, or that which moves down ward from us encounters the heads of those beneath us. For the motion in the two cases is conceived as extending to infinity in opposite directions throughout."

The author is attempting to meet the objection that in infinite space there is no up and down, which he grants, if up and down are used in an absolute sense as implying a highest and a lowest point in infinite space. But he goes on to defend the use of the terms in a relative sense, and to deny that the same direction can be at once both up and down in reference to the same point of space. If it be granted that a line starting from a given point in a given direction may be produced both ways to infinity, then, he contends, if we call motion along this line in one direction up, we may also call motion along this line in the opposite direction down. A falling body which moves in the direction from our head to our feet and straight on in the same direction to infinity has for us a downward motion, and what ever moves in the contrary direction from our feet to our heads and straight on in the same direction to infinity has for us an upward motion. From the infinity of worlds it may be inferred that there are some worlds vertically over our heads and others beneath our feet; in the last sentence but one we seem to find a reference to the inhabitants of such worlds. A point on the vertical line may be "down" from their stand-point, though it is "up" from ours, or vice versa.

"When they are travelling through the void and meet with no resistance, the atoms move with equal velocity. Nor will heavy atoms travel more quickly than small, light ones so long as they meet with no obstruction, nor small atoms travel more quickly than great ones so long as they find a passage suitable for their size and provided they also do not meet with any obstruction. Nor will their upward or lateral motion, which is due to collisions, nor, again, their downward motion, due to weight, increase or lessen their velocity. As long as their motion lasts, whether it be vertical or not, their velocity will be quick as thought until they meet with some obstruction, whether due to external collision or their own weight, which overcomes the force of a previous impact. Moreover, of the atoms in composite bodies, one will not travel faster than another, since all have equal velocity; and this whether we consider the motion of the atoms in an aggregate in one direction during sensible and continuous time or their motions in different directions in times so short as to be apprehended only by the reason. But they frequently collide and

are thrust back and forth before finally the continuity of their motion is appreciable by sense. For the assumption that beyond the range of direct observation even the minute times conceivable by reason will present continuity of motion is a gratuitous addition, which is not true in the case before us. Our canon is that direct observation by sense and direct apprehension by the mind are alone invariably true."

The atomic theory of Democritus, for whom the polemical allusions are intended, undergoes in this passage considerable modifications. We have no precise information what the earlier Atomists conceived the original motion of atoms to be. There is little or no ground for attributing to them the belief of Epicurus that every atom has inherent in it a downward tendency which we may, if we like, call gravity. Their cosmogony starts with a confused motion of colliding atoms which by the force of impact move vertically, laterally, and in all directions. At the same time it appears from Aristotle s criticisms that Democritus did really suppose that if two atoms, one larger and heavier, the other smaller and lighter, moved in the same direction, the former would over take the latter. Aristotle suggested that Democritus had omitted to take into account the resistance of the air, and that in perfectly empty space a large body and a small body would move with equal velocity. The opinion of Aristotle is indorsed by Epicurus, so firmly, indeed, that when he comes to the crux of his whole system he has to adopt a novel expedient to bring about collisions between atoms travelling with uniform velocity in the same direction. But of this more hereafter. In the present passage he simply affirms the uniform velocity of all atoms under all conditions and at all times, on the ground that they move in empty space which offers no obstruction. Such an affirmation bears an external resemblance to the doctrine of the conservation of energy. But Epicurus seems unconscious of the many assumptions which his statement involves. His atoms are absolutely hard and therefore inelastic. According to him the direction of motion changes after impact, but there is no loss of energy, and friction is ignored. His other concern is first with Democritus, whom apparently he charges with confounding motion in a medium such as air with motion in a void, and next with the interesting and different problem, to which we have already referred, of the motions of atoms in which looser or closer association form composite bodies. If we may expand the terse obscurity of the summary, the point he makes seems to be this. In motion of translation the whole composite body infinite time passes from point A to point B in a straight line. We are tempted, therefore, by the perversity of over-hasty presuppositions, and all those tendencies which we may call groundless opinion, inference, or belief, to argue that, if this finite time

be subdivided into atoms of time distinctly conceivable by the mind but too short to be apprehended by sense, the uniform motion of translation will be maintained through each of them, not only for the composite moving body as a whole, but for each of its component atoms. This he brands as a mistake. We have clear and distinct apprehensions by the mind which are trustworthy, because in them the mind seizes and grasps objective images. When we picture the actual course of a single atom in a composite body moving with motion of translation, we see clearly and distinctly that it does not describe a free course, but is in perpetual oscillation backward and forward on account of collision with the other atoms associated with it in the composite body, and we may suppose him to add this is the gist of the argument, though nowhere ex pressed that in this perpetual oscillation backward and forward each atom of the composite body moves with uniform velocity "quick as thought," as if it were moving singly and freely through space, although the movement of translation of the whole composite body, as attested by sense, is so immeasurably slower than the motion of the atom.

Lucretius describes the motion of the unimpeded atom as many times surpassing in velocity the sun s light and heat, which, he remarks, travel not through void but through intervening air. He corrects the error as he conceives it of Democritus thus: "But if haply any one believes that heavier bodies, as they are carried more quickly sheer through space, can fall from above on the lighter and so beget blows able to produce begetting motions, he goes most widely astray from true reason. For whenever bodies fall through water and thin air they must quicken their descents in proportion to their weights, because the body of water and subtle nature of air cannot retard everything in equal degree, but more readily give way, overpowered by the heavier; on the other hand, empty void cannot offer resistance to anything in any direction at any time, but must, as its nature craves, continually give way; and for this reason all things," i.e. all atoms, "must be moved and borne along with equal velocity though of unequal weights through the unresisting void."

But motion due to weight and motion due to collision are not, so Epicurus thinks, the whole account of the matter. It is unfortunate that we have not his own statement but are forced again to borrow from Lucretius who is, however, well supported by independent authorities. We must also remember that, if Epicurus comes off badly, he is setting out on an adventure which the more prudent Democritus declined. The question why things should be as they are does not concern an empiricist. It is enough for him to find out how they are. Aristotle expressly testifies that Leucippus and Democritus declined to give any cause of motion. They

said it was original, eternal, and without beginning, since each movement presupposes a preceding movement, and to seek for the beginning of an endless process is absurd. According to them a vortex motion of atoms preceded the very beginning of our world as it now exists. But beyond this they do not go back. Epicurus seems to have argued that vertical motion in the determinate direction which we call downward is prior to the motion resulting from collision, impact, and pressure, though why this should be so it is hard to see, and that atoms moving with equal velocity in the same direction would never collide. Feeling bound to offer some explanation, since both the tendency to fall downward and the collision seemed guaranteed by sense, he modified his premisses in an arbitrary manner by the gratuitous assumption of an atomic declination from the perpendicular to a minimum extent. Sense tells us that heavy bodies fall downward to the earth, but sense never can assure us that they do not diverge from the perpendicular, provided the divergence is too small for sense to discern. Here, again, he avails himself of that convenient loose second clause of the canon with its fatal flaw: "Nothing in our experience contradicts such an assumption." Certainly not, when the assumption is expressly removed from the region of trustworthy observation. The all important evidence of sense does not, because it cannot contradict an imperceptible swerving. Over this assumption opponents made merry, while apologists almost as unkind would persuade us that our philosopher actually introduced spontaneity into nature out of sheer aversion for the natural necessity of Democritus. According to M. Guyau, the power of atoms to decline from their path in whatever direction it is does not disappear after they have combined in matter, but still remains, endowing bodies with a power of spontaneous motion to a quite imperceptible degree. M. Guyau holds that such a blind latent force of spontaneity, working imperceptibly in the things around us, issues in those events which are ascribed to chance or accident. Instead of attributing atomic declination to so unworthy a motive we should rather regard it as a desperate device to which Epicurus thought himself driven, if, in Plutarch s words, stars and animals and chance and human action were to be saved from destruction. Here the same three causes can be distinguished as in the letter to Menceceus. The atoms by natural necessity have formed our world in which stars and animals are included; some things again are due to chance, while true spontaneity, as distinct from both of these, is to be found in human action alone. Atomic declination should be regarded, then, as coming under the first rather than the second or third of these heads. It is, Lucretius conceives, doubtless following Epicurus, a necessary postulate for the third, since the motions which are initiated by our

will are in the last analysis movements of soul atoms. Epicurus was no determinist where human action is concerned, because, as it seemed to him and has seemed to many others since, the testimony of consciousness contradicts the determinist position. The problem, then, was how to reconcile free-will or spontaneous initiative with mechanical necessity in the natural world. The solution which he tendered must be judged on its merits. It is perhaps not more successful than any other. But great as is the departure from the true doctrine of mechanical necessity which Democritus consistently maintained, this is a very different thing from calling in spontaneity as a principle in nature. But it is time to let Lucretius expound his master's doctrine in his own words: "When atoms are borne downward sheer through void by their own weights at quite uncertain times and uncertain spots they push themselves a little from their course; you just and only just can call it a change of inclination. If they were not used to swerve they would all fall down like drops of rain, through the deep void, and no clashing would have been begotten nor blow produced among the atoms; thus nature never would I have produced aught."

Here, then, we learn the truth. Go back as far as we may in the history of the universe, there is no rain of atoms downward. Epicurus, like Democritus, supposed atoms moving in all directions, the inherent force of pseudo-gravity with which Epicurus, in obedience to experience, endowed his atoms, being everywhere counteracted by the effects of collision. The actual universe shows on a large scale what we see of motes in a sunbeam, viz., a dance of particles in all directions. The ceaseless rain of eternal atoms racing through infinite space in the same downward direction, the conception which called forth the enthusiasm of Fleeming Jenkin, belongs to an unreal or imaginary universe in which free atoms never collide because they never decline. Such a conception Epicurus relegated to the limbo of false opinion, unreality, and error for the sufficient reason that our world, and infinite other worlds, actually exist, i.e., have come into being, which could never have happenedon the hypothesis rejected. After refuting the opinion attributed to Democritus, that heavier atoms fall more quickly and overtake lighter ones, Lucretius proceeds: Therefore heavier things will never be able to fall from above on lighter nor of themselves to beget blows sufficient to produce the varied motions by which nature carries on things. Wherefore, again and again I say bodies must swerve a little; and yet not more than the least possible, lest we be found to be imagining oblique motions, and this the reality should refute. For this we see to be plain and evident that weights, so far as in them is, cannot travel obliquely when they fall from above, at least so far as you can perceive; but that nothing swerves in any case from the

straight course, who is there that can perceive?" The qualifying clauses should be care fully noted.

Lucretius goes on to adduce the evidence of consciousness for our own power of spontaneous initiative. "Again, if all motion is ever linked together and a new motion ever springs from another in a fixed order and atoms do not by swerving make some, commencement of motion to break through the decrees of fate, that cause follow not cause from ever lasting, whence have all living creatures here on earth, whence, I ask, has been wrested from the fates the power by which we go forward whither the will leads each, by which likewise we change the direction of our motions neither at a fixed time nor fixed place but when and where the mind itself has prompted. For beyond a doubt in these things his own will makes for each a beginning and from this beginning motions are welled through the limbs. See you not, too, when the barriers are thrown open at a given moment, that yet the eager powers of the horses can not start forward so instantaneously as the mind itself desires? The whole store of matter through the whole body must be sought out in order that, stirred up through all the frame, it may follow with undivided effort the bent of the mind, so that you see the beginning of motion is born from the heart, and the action first commences in the will of the mind and next is transmitted through the whole body and frame. Quite different is the case when we move on propelled by a stroke inflicted by the strong might and strong compulsion of another; for then it is quite clear that all the matter of the whole body moves and is hurried on against our inclination until the will has reined it in throughout the limbs. Do you see, then, in this case that, though an outward force often pushes men on and compels them frequently to advance against their will, and to be hurried headlong on, there yet is something in our breast sufficient to struggle against and resist it? And when, too, this something chooses, the store of matter is compelled sometimes to change its course through the limbs and frame, and after it has been forced forward, is reined in and settles back into its place. Wherefore in atoms, too, you must admit the same, admit that besides blows and weights there is another cause of motions, from which this power of free action has been begotten in us, since we see that nothing can come from nothing. For weight forbids that all things be done by blows through, as it were, an outward force; but that the mind itself does not feel an internal necessity in all its actions, and is not, as it were, overmastered and compelled to bear and put up with this, is caused by a minute swerving of atoms at no fixed part of space and no fixed time." The cogency of this reasoning depends upon the Epicurean theory of the atomic constitution of the soul.

Epicurus now treats of the soul. "Next, with constant reference to our perceptions and feelings (for so we shall have the surest grounds for belief), we must understand generally that the soul is a corporeal thing, composed of fine particles, dispersed all over the frame, most nearly resembling wind with an admixture of heat, in some respects like wind, in others like heat, but in part even superior to both of them in the fineness of its particles, and on that account in closer sympathy with the rest of the frame. And this is shown by all the mental faculties and sensations, by the ease of mental motion and by thoughts, and by that the loss of which causes death. And we must keep in mind that soul has the greatest share in causing sensation. Still, it would not have had sensation had it not been confined within the rest of the frame. But the rest of the frame, though it provides this indispensable condition for the soul, and has itself, too, shared in a like property, yet does not possess all the attributes of soul. Hence on the departure of the soul it loses sensation."[21] This means that atoms of soul can neither have sensation themselves nor cause the body to have sensation unless they are confined in the body. When so con fined, they not only have sensation, but communicate it to the body, which becomes sentient. But other properties of the soul, e.g., the power to think, are not in this way communicated to the body, confinement in which is the indispensable condition that the soul should have sensation and thought. "For the body had not this power in itself, but something else when conjoined thereto procured it for the body, which other thing through the faculty brought to perfection in it in virtue of motion at once acquired for itself a quality of sentience, and in virtue of the neighbourhood and close sympathy between them, as I said, imparted it to the body also. Hence, so long as the soul is in the body, it never loses sentience through the loss of some other part. The frame may be loosened either wholly or in part and portions of the soul may thereby be lost. Yet in spite of this the soul, if it manages to survive, will continue to have sentience. But the rest of the frame, whether the whole of it survives or only a part, will no longer have sensation when once that has departed which, however small in amount, attunes the multitudinous atoms to harmony and life. Moreover, when the whole frame is broken up the soul is scattered, and has no longer the same powers as before, nor does it move, and hence it does not possess sentience. For we cannot conceive the sentient subject as otherwise than in this composite whole and moving with these movements; nor can we conceive it when the body which encloses and surrounds it is not the same as that in which the soul is now located and in which it performs these movements. There is

21 Epicurea, p. 19, 15 sqq.

a further point to observe; I mean, what the incorporeal is when the term is applied to a thing in itself incorporeal. It is impossible to conceive anything that is incorporeal in itself except empty space, which can not itself either act or be acted upon, but simply allows body to move through it. Hence those who call soul incorporeal talk foolishly. For if it were so it could neither act nor be acted upon. But, as it is, both these properties manifestly belong to soul. Thus, then, if we refer all these arguments concerning soul to the standard of our feelings and perceptions, and if we remember the propositions stated at the outset, we shall see that the subject has been adequately comprehended in outline and thus be able to verify with certainty the details.

This account is for the most part quite plain and easy to follow. Special stress is laid on the mutual relation and inter-connection between the soul and the body, such that neither can exist without the other. We also learn that soul is a corporeal thing, a very fine substance, and a composite substance, wind and heat being mentioned as two elements in the compound. The words "the frame may be loosened either wholly or in part and portions of the soul may thereby be lost" most probably refer to the effects of a deadly blow causing a swoon, so that for some time life is apparently extinct though recovery is occasion ally possible even then. If this is so the following parallel from Lucretius serves to interpret them: "Again, a blow more severe than its nature can endure prostrates at once any living thing and goes on to stun all the senses of body and mind. For the positions of the atoms are broken up and the vital motions entirely stopped until the matter, disordered by the shock through the whole frame, unties from the body the vital fastenings of the soul and scatters it abroad, and forces it out through all the pores. For what more can we suppose the infliction of a blow can do than shake from their place and break up the union of the several elements? Often, too, when the blow is inflicted with less violence the remaining vital motions are wont to prevail, ay, prevail and still the huge disorders caused by the blow and recall each part into its proper channels, and shake off the motion of death now reigning, as it were, paramount in the body and kindle afresh the almost lost senses. For in what other way should the thing be able to gather together its power of mind and come back to life from the very threshold of death, rather than speed on to the goal to which it had almost run and so pass away?"

In the third book of his poem Lucretius deals with the soul and goes over much the same ground as Epicurus, but with far greater fulness of detail, and the additional statements he makes are confirmed by casual references from other authorities, even where they at first sight conflict

with the bare summary given by his master. His account of the nature and composition of the soul starts with a refutation of the doctrine of harmony, so well known from its examination in Plato's Phcedo. This doctrine, which reduces the soul from an actual part of the man, co-ordinate with the body, to a mere relation or harmony between the various parts of the body, had been revived by Dicaearchus and Aristoxenus, pupils of Aristotle. Lucretius passes on next to distinguish in the single substance of the soul two parts which he calls animus and anima. The former he describes as the superior or ruling part and as localised in the breast, the latter as diffused through the whole body. "Now I assert that the mind and the soul are kept together in close union, and make up a single nature, but that the directing principle which we call mind and understanding is the head, so to speak, and reigns para mount in the whole body. It has a fixed seat in the middle region of the breast; here throb fear and apprehension, about these spots dwell soothing joys; therefore here is the understanding or mind. All the rest of the soul disseminated through the whole body obeys and moves at the will and inclination of the mind." Again: "And since we perceive that vital sense is in the whole body, and we see that it is all endowed with life, if on a sudden any force with swift blow shall have cut it in twain so as quite to dissever the two halves, the power of the soul will without doubt at the same time be cleft and cut asunder and dashed in twain together with the body."[22] A soldier s arm or foot or head, he goes on to say, cut off in the heat of battle will show for a time remains of sense and motion, and a serpent chopped in pieces may be seen to writhe and wriggle on the ground. These facts, which the poet adduces to prove that the soul is divisible and therefore mortal serve equally well to prove the diffusion of vital sense and therefore the presence of soul atoms through the whole frame.

Lucretius exaggerated the distinction between the two parts (1) animus or mens, and (2) anima by the choice of his Latin terms for them. Our Greek authorities speak of the former only as the ruling part of the soul and the latter as soul in general. It may be a consciousness of this exaggeration that leads the poet subsequently to say that he will in future ignore the difference between them and treat the animus and the anima as one single substance. 3 There is, indeed, merely a difference of function be tween them, and this may be traced back to the fact that in the breast soul atoms are closely huddled together and thus give rise to atomic motions more complicated than is the case when they are dispersed through the limbs and the periphery of the body, and are comparatively rare. These atoms are in all cases exceedingly minute, smooth,

22 III, 136 sqq.

and spherical. But in the composite substance which they unite to form can be distinguished not only atoms of wind and of heat, but also atoms of air and of a fourth nameless substance in which all sensation begins. In the summary given by Epicurus above, the third and fourth classes of constituent atoms, the atoms of air and of the nameless substance are passed over, but that he recognised them is a well-attested fact. It causes some surprise that any distinction at all should be made between wind and air, especially when we learn from Lucretius that "wind is produced when the air has been stirred and set in motion."[23] But air, according to Epicurus, is not, so to speak, a simple body, but is composed of atoms which, though always fine and smooth, are yet of different kinds, some of them fiery, some moist, together with atoms of various things which have been evaporated or pulverised. In fact, the atmosphere is a medley of atoms of all sorts of things, provided these things have been volatilised. The poet tells us that "the air is changed over its whole body every hour in countless ways. For whatever ebbs from things is all borne away always into the great sea of air; and unless it in return were to give back bodies to things and to recruit them as they ebb, all things ere now would have been dissolved and changed into air,"[24] i.e they would have entered into that medley of which the atmosphere is constituted. It has been suggested[25] that the exact difference between air and wind is one of temperature, and that in air there is a predominance of atoms such as constitute a medium or calm temperature in the wind which blows a predominance of atoms slightly larger and less smooth, such as constitute a cold temperature. As to the fourth sub stance which Lucretius calls the "soul of the soul," the idea of some scholars that it was confined to the breast is preposterous and absurd, for, if sensation starts with it, it must be present in every part of the frame which has sensation and therefore it must be a constituent of every part of the soul. Moreover, the doxographers inform us that in the opinion of Epicurus sensation took place in the various sense-organs, the eye, the ear, the tongue, the nostrils and was not, as some other schools held, localised in or transferred to a central organ, heart or brain. Lucretius thus describes the part which this fourth nameless substance takes in the initiation and trans mission of sensation. "Thus some fourth nature, too, must be added to these: it is altogether without name; than it nothing exists more nimble or more fine, or of smaller or smoother elements: it first transmits the sense-giving motions through the frame; for it is first stirred, made up as it is of

23 VI, 685.

24 V, 275 sqq.

25 Giussani, Studi Lucreziani, p. 184.

small particles; next the heat and the unseen force of the wind receive the motions, then the air; then all things are set in action, the blood is stirred, every part of the flesh is filled with sensation; last of all the feeling is transmitted to the bones and marrow, whether it be one of pleasure or an opposite excitement.[26]

Epicurus next explains the nature and mode of existence which be ascribes to his two classes of qualities, the permanent properties, coniuncta and the variable accidents, eventa. "Shapes and colours, magnitude and weights, and, in short, all those qualities which are predicated of body are properties, either of all bodies or of visible bodies, and can be known as belonging to body by sense-perception. All these properties must not be supposed to exist independently by themselves (for this is inconceivable), nor again to be non-existent nor to be some other incorporeal essences present in body besides, nor yet to be parts of body. We must consider a whole body in general to derive its permanent nature from them, though it is not, as it were, formed by grouping them together in the same way as when from the particles themselves a larger aggregate is made up, whether these particles be primary," i.e., the least perceptible which have the property in question, "or any parts whatsoever less than the particular whole. All these qualities, I repeat, merely give to body its own permanent nature. They all have their own characteristic modes of being perceived along with the whole body in which they inhere and never as separated from it; and it is in virtue of this complex conception of body that they have received the appellation of properties."

"Again, qualities often attach to bodies without being permanent concomitants. They are not to be classed among invisible entities nor are they incorporeal. Hence, using the term "accidents" in its commonest sense, we say plainly that "accidents" have not the nature of the whole thing to which they belong, and to which, conceiving it as a whole, we give the name of body, nor that of the permanent properties without which body cannot be thought of. And in virtue of certain peculiar modes of cognition into which the complex body always enters each of them can be called an accident. But the object, whatever it is, in which the accident is said to inhere, does not derive its permanent nature from the accidents which accompany it. There is no need to banish from reality this clear evidence that the accident has not the nature of the whole to which it belongs, nor of the permanent properties which ac company the whole. Nor must we suppose the accident to have permanent existence (for this is as inconceivable in the case of accidents as in that of the permanent properties). They are what they appear to be. They must all be regarded

26 III, 241 sqq.

as apeiaents of body, not as permanent concomitants nor as having the rank of independent existence. They are seen to be exactly as sensation itself makes known their individuality."

The question what we mean when we say that an attribute exists is bound up with another question, what exactly is meant by saying that a thing has an attribute or quality, the question of the import of predication. On both points ancient and modern thinkers have been much divided. In some of his dialogues Plato implies that there are "ideas," as he calls them, of qualities, that qualities like beauty are self-existent realities or essences, and that a particular thing is beautiful because it partakes in self-existent beauty, which therefore is immanent in it. This Platonic view is the first which Epicurus rejects. Again, in disclaiming the absolute non-existence of properties he probably refers to Democritus, who asserted that colour, sound, and odour did not in reality belong to the external objects which we perceive as coloured, sonant, and odorous. The view that qualities are "other incorporeal existences present in body" is that of Aristotle, the view that qualities are material parts of objects that of the Stoics.

Now as to time. "There is another thing which we must consider carefully. We must not investigate time as we do the other accidents which we investigate in a subject, viz., by referring them to the generic types present to our minds, but we must simply attend to the intuitive action itself in virtue of which we speak of a long time or a short time in the common acceptation of the term. We need not adopt any fresh terms as preferable, but should employ the usual expressions about it. Nor need we predicate anything else of time, as if this something else contained the same essence as is contained in the proper meaning of the word time (for this is also done by some)." Time had been defined as "number of motion " or " measure of motion." Epicurus does not think this makes the idea conveyed by the word time any clearer. "We must chiefly attend to that to which we attach this peculiar character of time and whereby we measure it. No further proof is required; we have only to reflect that we attach time to days and nights and their parts, and likewise to feelings of pleasure and pain and to neutral states, to states of movement and states of rest, and consider that time itself is a peculiar accident of all these, and so it is in virtue of this accident that we apply the name time."

Unlike empty space, which has real and separate existence, time, as above explained, is merely an accident, and, further, that to which it attaches, that of which it is an accident, is not anything real or corporeal but is itself an accident. Time, then, is an accident of accidents, an accident of events or occurrences in the present, past, or future. This point

is brought out by Lucretius thus: "Time, also, has no separate existence, and it is due simply to events that happen that our mind grasps what has taken place in the past, and also what is happening now, and, further, what follows in the future. We must admit that no one has a perception of time in the abstract, apart from the movement of events, whether fast or slow. Further, when men say that events like the rape of Helen and the conquest of the Trojan people by the sword have existence, we must be careful that they do not haply force us to admit that these events have separate existence, on the ground that the generations of men, of whom these were the accidents, have been carried away by time now gone by without recall. For whatever may have taken place may be called an accident, in one aspect, of the Trojan people,[27] but in another aspect, of the country itself. Further, if there had been no matter and no place and room, in which the different processes go on, never would the fire, kindled by love of Helen's beauty, have blazed in the heart of Phrygian Paris, and kindled that famous contest of cruel war; nor would the wooden horse, unknown to the Trojans, have set fire to Pergamus by the hand of the Greeks who came forth from its womb in the night. Hence you can clearly see that all events from first to last have no separate existence or being as body has, and are not terms of the same kind as void is; rather they are such that you may justly call them accidents of body and accidents of place in which the different processes go on."[28]

"Next," Epicurus goes on, "we must consider that the worlds and every finite aggregate which bears a strong resemblance to the things we see have arisen out of the infinite. For all these, whether small or great, have been separated off from special conglomerationsof atoms, and all things are again dissolved, some faster, some slower, some through the action of one set of causes, others through the action of an other. And we must not suppose that the worlds have necessarily one and the same shape. For nobody could prove that in one sort of world there could equally well not be found as be found the seeds out of which animals and plants and all the rest of the things we see arise, and that in another sort of world this would have been impossible." "Again, we must suppose that human nature, too, has been taught and forced to learn many various lessons by the facts themselves, and that reason subsequently develops what it has thus received and makes fresh discoveries, among some men more quickly, among others more slowly. Hence, even the names of things were not originally due to convention, but in the several tribes under the impulse of special feelings and special presentations of

27 1 Reading Teucris with Munro for terris.

28 1, 459 sgq.

sense primitive man uttered cries. The air thus emitted was moulded by their individual feelings or sense- presentations, and differently according to the difference in the regions which the tribes inhabited. Subsequently whole tribes adopted their own special names in order that their communications might be less ambiguous to each other and more briefly expressed. Some men, we must suppose, who knew about them, tried to introduce the notion of things not visible, and put in circulation certain names for them, which they were compelled to utter, while the others, following their reason as best they could, interpreted them in that sense."

There is no plan in nature, says Epicurus, nothing which can be referred to supernatural will or agency."We are bound to believe that in the heavens revolutions, solstices, eclipses, risings, and settings and the like take place without the intervention or command, either now or in the future, of any being who at the same time enjoys perfect bliss along with immortality. For troubles and anxieties and feelings of anger and favour do not accord with bliss, but always imply weakness and fear and dependence upon one's neighbours. Nor, again, must we hold that ignited globular masses of fire, endowed with bliss, produce these motions at will. Nay, in every term we use we must hold fast to all the majesty which attaches to such notions as bliss and immortality lest the terms should generate beliefs inconsistent with this majesty. Otherwise such inconsistency will of itself suffice to produce disturbance in our minds. Hence, where we find phenomena invariably recurring, the invariableness of the recurrence must be ascribed to the original interception and conglomeration of atoms cut off from the infinite, whereby the world was formed."

This passage, to be fully appreciated, must be read in the light of the antagonistic Stoical doctrine which is so pointedly assailed. The stars, according to the Stoics, were "globular masses of fire," and yet at the same time were rational and supremely happy beings, endowed with life as well as self-motion. Epicurus first points out that the intelligent government of the world is fatal to the immortality of bliss which is the divine prerogative, and then tenders a different explanation of the order and regularity of phenomena. The sun rises and sets regularly only because the combination of atoms evolves that particular change again and again with an approximation to uniformity.

"We must hold that to arrive at accurate knowledge of the cause of the things of most moment is the business of natural science and that happiness depends upon this and upon knowing what the heavenly bodies really are, and anything else which contributes to exact knowledge in this respect. Further, we must recognise no plurality of causes or contingency in the things of most moment, but must hold that nothing suggestive of

conflict or disquiet is compatible with an immortal and blessed nature. And the intellect can grasp the absolute truth of this." By the "matters of greatest moment" Epicurus means the exclusion of the gods or any supernatural agency whatever from the government of the world. This he considers fully established and absolutely certain. No alternative hypotheses or contingencies are admissible on this subject. This is all we know for certain and all we need to know.

"But when we come to subjects for special inquiry there is nothing in the knowledge of risings and settings and solstices and eclipses and all kindred subjects that contributes to our happiness, but those who are well-informed about such matters, and yet are ignorant what the heavenly bodies really are, and what are the most important causes of phenomena, feel quite as much fear as those who have no such special information; nay, perhaps even greater fear when the curiosity excited by this additional knowledge cannot find satisfaction nor subordinate these phenomena to the highest causes. Hence, if we dis cover more than one cause to account for solstices, settings and risings, eclipses and the like, as we did also in particular matters of detail, we must not suppose that our treatment of these matters fails of accuracy so far as it is needful to insure our tranquillity and happiness. When, therefore, we investigate the causes of celestial and meteorological phenomena, as of all that is unknown, we must take into account the variety of ways in which analogous occurrences happen within our experience; while as for those who do not know the difference between what is or comes about from a single cause and what is the effect of many causes, who overlook the different impression which things make upon us when seen from a distance, and so are ignorant of the sort of matters which leave our tranquillity unaffected, all such men we must treat with contempt. If, then, we believe that an event could happen in one or other particular way out of several which leave our tranquillity unaffected, we shall be as tranquil when we are aware that it actually does come about in more ways than one as we should be if we knew that it happens in only one particular way."

The argument is this: When the same effect is known to have more than one cause, and we are uncertain to which of these causes it is to be referred in a particular case, then if we are sure that the question whether it is to be referred to cause A or to cause B does not affect our tranquillity, we need not carry the investigation any further. The knowledge that of all the causes which bring about this effect there is none that in any way disturbs our tranquillity, conduces to that tranquillity just as much as would the precise knowledge to which of these given causes the effect on a given occasion is due. How this principle works may be seen from

the application made by Epicurus himself in the extant letter to Pythocles.[29] The fifth and sixth books of the poem of Lucretius traverse the same ground and the same method is there employed. In investigating a phenomenon of the class defined whose cause is un known, Epicurus, on principle, stops short so soon as he has reached a plurality of causes any one of which is upon analogy judged capable of producing the effect under investigation without calling in supernatural agency. Over the results so obtained, which will appear to some ludicrous, to others lamentable, the friends of the philosopher will prefer to throw a veil.

There is yet one more point to seize, viz., that the greatest anxiety of the human mind arises through the belief that these heavenly bodies are blessed and eternal, and that at the same time they have wills and actions and causality inconsistent with this belief, and through expecting and apprehending some everlasting evil either because of the myths or be cause we are in dread of the insensibility of death, as if it had to do with us, and through being reduced to this state not by conviction, but by a certain irrational perversity, so that, if we do not set bounds to our terror, we endure as much or even more intense anxiety than if we held these beliefs. But mental tranquillity means to be released from all these troubles and to cherish a continual remembrance of the highest and most important truths. Hence we must attend to present feelings and sense-perceptions, whether those of mankind in general or those peculiar to the individual, and to all the clear evidence at hand, given by each of the standards of truth. For by studying them we shall rightly trace to its cause and banish the source of disturbance and dread, accounting for celestial phenomena and the rest of the things which from time to time befall, which cause the utmost alarm to the rest of mankind."

This brings us very nearly to the close of the letter to Herodotus in which Epicurus, as he goes on to say, has given an epitome of his physical theory so adequate and yet so compressed that he recommends his pupil to commit it to memory. Once more, it will be seen, he emphasises the subordination of all physical inquiries to ethical considerations. His sole aim is to banish for ever from the mind those fertile sources of disturbance, superstition, and terror. In so far as these anxieties are due to ignorance, their proper cure is knowledge, and within these bounds the pursuit of knowledge should be encouraged, not for its own sake far from it but as the indispensable means to the great end of life, the tranquillity of the individual. In the same spirit Lucretius, who so faithfully reproduces his master s teaching, commences his great task. At the outset of his poem, after he has adduced the sacrifice of Iphigenia as the crown-

29 1 Diogenes Laertius, Book X, 84-116; Epicurea, pp. 35-55.

ing instance of the evils prompted by religion, he introduces the first of the long series of Epicurean dogmas with these words: "This terror, then, and darkness of mind must be dispelled, not by the rays of the sun and glittering shafts of day, but by the aspect and the law of nature; the warp of whose design we shall begin with this first principle, nothing is ever gotten out of nothing by divine power. Fear, in sooth, holds so in check all mortals, because they see many operations go on in earth and heaven, the causes of which they can in no way understand, believing them, therefore, to be done by power divine. For these reasons when we shall have seen that nothingcan be produced from nothing, we shall then more correctly ascertain that which we are seeking, both the elements out of which everything can be produced and the manner in which all things are done without the hand of the gods." Master and pupil are at one in striving for spiritual freedom.

R.D. Hicks. *Stoic and Epicurean.* New York: Russell and Russell, 1962. This text is in the public domain.