Joseph Lalumia

FROM SCIENCE TO METAPHYSICS AND PHILOSOPHY

INTRODUCTION

Most historians of science and historians of philosophy have advanced the doctrine that philosophy preceded science, the so-called Pre-socratics from Thales to Democritus being the philosophers who provided the stimulus for science to begin.

There are a few historians who see the Pre-socratics as scientists. However, these historians seem without exception to be uncertain about two of the Pre-socratics: Parmenides, who appears to them to be essentially a philosopher or a logician, and Zeno, the Eleatic, who excites their attention mainly because of the influence of his paradoxes reflected in the history of mathematics.

Further, it is often noted by different writers that contemporary philosophy is a revolutionary departure from classic modern philosophy and from medieval and ancient philosophy. But, if I am not mistaken, there is continuity demonstrable in the history of philosophy from Parmenides and Zeno to the present, and the revolution alleged shows a superficial understanding of what philosophers do compared to what scientists do that Immanuel Kant was possibly the first philosopher to perceive, although his perception was incomplete.

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Accordingly, in this paper, I hope to show how the history of philosophy and the history of science would be more coherent, and how the relations of philosophy and science as well as the continuity of each of them from the Pre-socratics to the present day would be clear if there could be agreement that Parmenides and Zeno were, in fact, not only the first Western philosophers, but philosophers of science. This implies that, contrary to the doctrine mentioned above, science preceded philosophy and provided the stimulus for philosophy to begin.

IONIAN PHYSICS AND PARMENIDES

The Beginnings of Theoretical Science

Nearly all historians agree that the Ionian coast in the 6th century B.C., was the *mise-en-scène* of a remarkable phenomenon unprecedented in any other part of the world. The phenomenon was nothing less than a dialogue amounting to the institution of a new profession. Although many historians have imagined it to be philosophy, the new profession was natural science, but, more exactly, theoretical physics, the science that seeks to determine with ever more and more refinement the constitution of all matter.

It is important to be clear about what is meant by this claim. Some historians have seemed to think that the Greeks invented rational and empirical investigation, wholly forgetting that there were great civilizations that were older and that these could scarcely have become great without mastering and codifying many different classes of fact impossible to know without reasoning and observation. The beginnings of science cannot be identified with someone's performing for the first time some act, or even all the acts, supposed to constitute the scientific method. These acts—observation, generalization, hypothesis, recourse to experience, theory-making—are not, as acts, peculiar to science. Every human being at some time or other performs a number of them, or even all of them, in connection with the pursuit of innumerable objectives—war, travel, farming, hunting, manufacture, building, healing, and even pleasure. What, then, is peculiar to science, and to the Ionian thinkers with whom science began? The answer lies in the fact that most human beings do not seek

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knowledge as a matter of profession whereas scientists do. The true novelty of the physical thinkers of Ionia is that we can see in their achievement the germination in social awareness that the investigation of nature might be, not just an incident of living, but a way of living, that is, a role and a profession that a person might claim to practice with expectation of social comprehension and acceptance. For this is just what one does not find in ancient societies before the 6th century B.C.

In Babylonia there were men whose main business was to study the stars, but this was something they did in their role as calendarmakers and advisors to the king. Geometrical knowledge in Egypt consisted of trade-secrets of the surveyor. There were no chemists as we understand them, but there were doctors, perfumers, and makers of dyes, poisons, and drugs. In a word, all the professions, all the occupational roles, all the ways of making a living that enjoyed social validity were arts or activities ancillary to the arts.

Further, it is undeniable that the history of technology is much greater than that of science, so that while there is nothing remarkable about supposing that science began in the 6th century B.C., it would be patently preposterous for anyone to make the same sort of claim for the beginnings of technology. Benjamin Farrington has maintained that it was prejudicial for ancient science to be affected by social and political conditions that separated its practitioners from practitioners in the crafts, and there is a good deal of truth in this, but even he seems to have felt obliged to note the special claim of the 6th century B.C. for identifying the appearance in history of the scientific role as distinguished from the technological role.[1] For it is not technological achievement or even the pursuit of technological achievement for which the Ionian thinkers of the 6th century B.C. have enjoyed their place in history, but a theoretical achievement.

The Significance of Thales.

Thales, universally considered to be the first thinker of importance for understanding the theoretical achievement in question, owes his importance to a single doctrine: that matter, despite

[1] B. Farrington, *Greek Science*, New York, Penguin, 1944, Chapter 1.

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its apparent heterogeneity in space and transformations in time, has the same constitution or composition everywhere, namely water. Although this may appear crude to us, it must be remembered that he could hardly have been expected to say, as some chemists of the 19th century did, that matter everywhere is composed of hydrogen. The important thing is that he seems to have generated interest in just the *kind* of question it is necessary to have interest in if there is eventually to be a doctrine that the world is simpler than it looks and that all of it is built up from 92 elements or 100.

Thales' reasons for his view seem to have consisted mainly of analogies but we should be tolerant of this also for the following reason. Methods never precede a job's being undertaken but rather there being a job to do is what excites the creation of a method suited to doing it. Here, once more, there is the danger of looking for the beginnings of science in someone's using for the first time what is called the "scientific method," whereas one should look for the beginnings of science in someone's setting himself a task such as that which science now relies on the scientific method to accomplish. The aim of science is not its method. Its aim is understanding the world, and its method now is a tool which it has developed and learned to rely upon from centuries of effort to realize its aim. Moreover, questions of method usually do not arise unless efforts to accomplish a task have been made and have failed. When that happens something like self-examination takes over and the accomplishment of a task is suspended temporarily. This is why questions of methodology (as distinct from questions of technique) are almost always philosophical questions and this is why sciences that are or that become methodologically uneasy reflect it by producing more writings of a philosophical nature, as, for instance, in much of psychology and recent physics. Science, in brief, began before its method did, and the method of science today is the result of the phenomenon that men engaged in learning about some class of phenomena not only learn about the phenomena in which they are interested that way, but also learn about how to learn.

There is a more subtle aspect to this question of method in connection with the beginnings of science, however, and some attention must be paid to it for the sake of clarity. That Thales

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was not experimental is unimportant. But putting the kind of question he put and answering it the way he did would not have sufficed by itself to make the beginnings of science as we know it possible. If one looks at Greek mythology, one will discover that other people *before* Thales had said that everything in the world is constituted of the same kind of stuff and that the stuff is water. But these people were poets and seers. Poets and seers in ancient society enjoyed a special position. They were supposed to be gifted with a special sort of insight, so that if a seer said that everything was made of water, it was his special gift of insight that was supposed to make him say it. This meant that when the seer spoke, he spoke as one gifted to see a truth to other people not gifted to see it, so that no argument with him was called for and no give and take of reasons was involved.

Hence, the important thing about Thales and his doctrine that everything in the world is made of water is that in insisting on his doctrine he does not seem to have stood on a claim that he was a seer or on social recognition of himself as such a person, but rather on a claim to have reasons that would be persuasive to anybody who took the trouble to consider them. That is to say, he invited and challenged criticism or a test. This is important because when we talk about the beginnings of science we have to be talking about the beginnings of a dialogue, not a soliloquy. Dialogues are peculiar in that they are possible only between people who can count as equals, because there is tacit agreement that they enjoy common access to the subject-matter and common ability to weigh the merits of a claim or argument about it. That Thales, in advancing his doctrine, behaved in this social manner which is so necessary for a science as we know it, is amply indicated by the tradition known to Aristotle of certain straightforward reasons Thales gave for his view (for instance: animal sperm is wet, the fertility of the lands adjoining the Nile depends importantly on the Nile's annual overflow, water falls from the sky and water rushes to the land-surface from sources underneath, the oceans appear to exceed the land-masses in extent, earth in the form of sediment seems to come from water, the hot sun seems to dry up wet places by drawing up the water that makes them wet, as if converting water into its own substance, etc.). But it is better indicated by the fact that the next thinker of scientific importance, Anaximander, not only

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disagreed with Thales, but gave reasons why all persons should disagree. This means that the idea was catching on that disagreement was fair providing it was not arbitrary, and it means that the idea was catching on that logic and truth are social.

Anaximander.

Thales had said that everything is made of water. Anaximander disagreed on the ground mainly that if everything were really water the familiar cycle of four seasons should gradually disappear and be followed by rather uniformly wet conditions all the time. Nothing like that seemed really to be happening. Moreover, if everything in the world were constituted of the same sort of stuff, that stuff could not be fire or earth or air anymore than it could be water. If it were fire, everything in the course of time should appear to be getting drier and hotter, the qualities of fire should appear to be gaining on the qualities that conspicuously characterize earth or air or water. And the same argument could be applied against the supposition that earth might be the fundamental single constituent, or air. (Note what is happening: what has begun is the evolution of the concept of an *element*, and earth, air, fire, and water are the candidates being considered for selection as the single element from which all substances must have been built up and are built up despite appearances to the contrary).

A disagreement in science is normally a disagreement about the right answer to a question, but sometimes it is a disagreement about the rightness of the question itself. Anaximander's disagreement with Thales is of the former and less radical kind. The question is: what is the single stuff of which all substances are made? Anaximander accepts this question, he agrees that all substances are constituted of the same stuff or material. But he does not agree that water provides the answer, and, moreover, he does not agree that water *can* be the answer or even that any of the other kinds of stuff being considered such as fire or air or earth *could* be the answer. The point is worth observing in passing to suggest that crises in science usually involve disagreement of the second kind or realization that the wrong kind of question is being asked.

Anaximander's decision was that all substances derive from, are resolved back into, and are at any time constituted of, a stuff

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he calls *To Apeiron*, i.e., The Indefinite. This stuff is exactly what he calls it. It is a mass of material in which no qualities that characterize earth, air, fire, and water are discernible and in which no limit or boundary is discernible. And this is logical, for he agrees with Thales that the stuff of the world is homogeneous in character and he believes, as said before, that if the stuff were distinguishable as earth, air, fire, or water seem to be distinguishable, there ought to be some evidence of this in time such as moisture's gaining on dryness or moisture's drying up. But even this is unsatisfactory, for we have to understand how substances as apparently different as earth, air, fire, and water could have come, or could have been formed, from the Indefinite. Accordingly, we find Anaximander postulating that the Indefinite Mass must be something in constant vortical motion and that the vortical motion causes earth, air, fire and water to be "separated out." This is still unsatisfactory for a number of reasons that it is better to mention later.

Anaximenes.

According to this thinker, both Thales and Anaximander are wrong. The stuff of the world is all the same, but it is air. There is nothing but air in motion. This is not obvious, but the truth is not obvious or scientific research would not be needed to tell us what it is. Indeed, all the thinkers so far reviewed question the obvious; all of them have been applying a distinction that scientific work always applies, the distinction between what seems to be so and what is really so. It isn't obvious that my fist's composition is atomic but science says it is atomic anyway. All of these men are on a journey destined to eventuate in saying just such things as that my fist is a number of atoms in some relationship and nothing more.

An object that I can see and that, moreover, is hard to the touch, is, according to Anaximenes, a great amount of air packed into a very small space. Take a block of ice that subsequently melts in a pail. Both the ice and the water that it becomes afterward are tangible, but if I try to shove my fist through the ice I experience considerable resistance, that is, I discover that it is hard, whereas if I push my fist through the water I discover that the water is soft. Suppose the water is boiled; now the water becomes vapor or air, that is, a substance that makes me

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experience no appreciable resistance when I push my fist through it and a substance that I can't even see. Now, what relation is there between the block of ice, the water it becomes after, and the vapor or air that the water becomes after that? Anaximenes' answer is that there are appearances of earth or solids, water or liquids, and air or gases (as we should say) depending upon whether the same quantity of original air occupies a lot of space or a very little space. In other words, apparent differences of material all depend on changes in density of a single material. If rarefaction goes on, density gets less, and if condensation is going on density is increased, with appearances changing accordingly. And rarefaction and condensation are nothing but a matter of distances getting greater or getting smaller between bits and parts of a single kind of stuff constituting any object, namely air. In this way, we can explain a change like the change from ice to water to mist or air. In this way we can also make good one's saying that everything there is has the same composition despite how different things seem to be from each other. Air is evident or inevident (opaque or transparent), hard or soft, tangible or intangible, massy or flimsy, sluggish or quick, appreciable or inappreciable in a sensory way, according to the density of it anywhere.

The superiority of this theory to that of Anaximander with respect to the variety of qualitative phenomena it provides for deserves notice. The qualities of matter that appear to have chiefly impressed the Ionian thinkers were hotness, dryness, wetness, and cold. Fire was hot and dry, air (mist, fog) was warm and wet, earth was cold and dry, and water was cold and wet. Anaximenes stands out as an extraordinary exception in that he tends to distinguish earth, air, fire, and water in terms of grades of appreciable tangibility (hardness or thickness and softness or thinness), optical discernibility (opacity to transparency), and dynamical character (sluggishness to quickness) of the same material, namely air. There is good reason to believe that this theory of matter exercised a strong influence on the theory of natural, vital, and animal spirits in the work of physiologists in later centuries from Galen to Harvey and Descartes.[2]

[2] "Spirits" should be understood here as in "spirits of alcohol." In Galen's physiological theory "natural," "vital," and "animal" spirits stood for venous blood (thick, dark red, and sluggish), arterial blood (thinner, bright red, and faster than venous blood) and air (lighter than arterial blood, colorless, and

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Theoretical Physicists, Not Philosophers.

It is worth stopping here for a moment and asking ourselves what it seems these men have been doing. It is not philosophy. It is obviously primitive theoretical physics. There are no questions such as we are accustomed to call philosophical, and there are no philosophical answers. There are physical questions, like Robert Boyle asking in the 17th century: What is the composition of atmospheric air? Or like Joseph Black asking: What is chalk? and finding out that it is calcium and carbon dioxide or "fixed air." There is no logical self-consciousness, there is no suspicion about one's assumptions, and no attention to one's logic and one's answers in relation to one's assumptions. Rather, there is the playing out of an assumption or the application of an assumption (that a single stuff constitutes everything there is) to the purpose of satisfying curiosity about the sea, and mountains, and weather, and clouds, and smoke, and the hardness and softness of materials.

This primitive theoretical physics is not prompted by experiments such as we are biased to look for in anything that we should now call science, but there is no good reason yet why it should be. Physics at this stage is rather like astronomy which is concerned to have a theory about matters the observation of which is normally not the result of human manipulation of factors imagined to be involved. Besides, a method is refined when there is some reason to believe that the method so far relied upon will not do for settling opinion on a question. In any case, even when physics does become experimental, it does so for the sake of a more satisfactory termination of dialogue about the relative merits of different hypotheses that have been advanced. The efforts of these men are efforts belonging in physics because they have to do with physical questions. It is as silly to say that the activity involved is not physical science because the method involved is not a method that physics uses now as it would be to say that housepainting with a handbrush was not really

very swift) which the motor nerves were thought to convey from the brain to the muscles to execute the behavioral decisions of the animal. Vital spirit was considered to be the product of some refinement of natural spirit, and animal spirit the product of a further refinement of vital spirit, all the refinements amounting to progressive steps in a process of rarefaction that the chemistry of the body accomplished.

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housepainting because it was not housepainting with a spray gun or a roller-brush. Science is a job and our concern here is with the historical beginnings of that job, while the method of science is a tool that science has developed and perfected in the course of its efforts to realize the objectives that characterize it as a job. Finally, the efforts of these men are scientific because, although experiments do not figure in them, the logic that figures in them is a logic that evidently makes observations relevant for answering the kind of questions being asked. *Any* experienced change and *any* experienced variety is what the theory sought is being required to fit, so that the relevance of experience of change and variety associated with experiments that it might occur to someone to make is in principle provided for. The significant question to be asked is: a movement or dialogue of this kind having been started, can it be expected to lead to experiments being made, and the answer seems to be that it certainly can. It seems harsh to say it, but it seems to be true nevertheless that the opposite view is based on nothing more than an unreflecting modern scientific conceit amalgamated with an utter lack of a sense of historical development, as if you could have men without first having little boys. As the question of the physical thinkers we have been considering was about the makeup of substance in the world, then, when one considers how long it took to invent something like the pneumatic trough for handling experimentally the simpler question about the makeup of atmospheric air alone, one may appreciate that these men had at least the curiosity and boldness and logical feeling to make the beginning which they did.

Anamalousness of Parmenides.

The place of the thinker presently to be considered is anomalous and controversial. In histories of philosophy he is always dealt with as of great importance; in histories of science he is either ignored or treated with uncertainty about his belonging in a history of science. The fact is that he is not a scientist or a physicist, but rather a philosopher of science, and perhaps the first Western philosopher. When we see what he has to say we shall see that he behaves, not like a person who has done investigations into the question of the world's makeup, but like an analyst of the investigations of others into this question. A man with an

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approach like this stands a chance of learning something about the world explored by physicists that the physicists conducting their explorations stand little or no chance of learning because the physicists are thinking about the behavior of matter while he is thinking about the relevant behavior of the physicists. Consequently, what we shall see is that his theory of the world does not say what the world *is*, but rather says what the world *has to be*, if one only thinks of what all the physicists have been assuming. Since he agrees with Thales, Anaximander, and Anaximenes that the world consists of a single homogeneous stuff, the criticism of Thales, Anaximander, and Anaximenes that is implied is that they did not think of his own theory of the world themselves only because they did not realize what they were doing, that is to say, they advanced the different theories they did because they did not realize that theories like theirs were inconsistent with the assumption they were all making. Now this is something that people do who do not understand their own assumptions, it is something that people do who are not logically self-conscious. Accordingly, it will be convenient to explain the ideas of Parmenides by taking one of the previous physical thinkers, Anaximenes, and comparing three things: what he assumed, what he said, and what his assumption would have made him say, had he appreciated its implications.

Parmenides as Critic of Ionian Physics.

The assumption of Anaximenes, like that of Thales and Anaximander, was that variety and change in the world hide or conceal oneness and identity, that variety and change are the "looks" of the world but that the "reality" is a single homogeneous stuff. But what was the nature of this stuff? Anaximenes' answer was that it is air and he proceeded to show how this could be true by arguing that apparent coexisting differences and apparent change are due to air's being or getting thinner in some places and being or getting thicker in other places. My fist, for example, does not look like air, but it is air all the same, and the cream cheese on the table does not look like air but it is air all the same, too.

But now, consider, What is there between the fist and the cream cheese? Be careful before you answer. I am not asking what *seems* to be between the fist and the cream cheese, but

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what is there *really* between the fist and the cream cheese. The answer, by Anaximenes' assumption, has got to be "air," for the simple reason that his assumption is that air is all that's real. So there is air where there seems to be a fist, air where there seems to be cream cheese, and air between the fist and the cream cheese. The reader might be inclined to say, "Hold on, there's space between the fist and the cream cheese." But then I reply on Parmenides' behalf: "This space you have just mentioned is either real, in which case your assumption requires for it to be air, or else this space is not real, in which case there is no space between the fist and the cream cheese. Now, take any alternative you choose. The result will be that the fist and the cream cheese cannot be said to be really different qualitatively and they cannot be said to be really discrete or different numerically." But, the reader will say, the theory of Anaximenes *explains* the apparent hardness of the fist as compared to the cream cheese. But that is not really true, because to explain the hardness of the fist Anaximenes asks us to think of the fist as constituted of lots of air closely packed, and to explain the softness of the cream cheese he asks us to think of air loosely packed. How can one think of air this way, however, unless one thinks of it as available in bits with small or large spaces between the bits? If one is thinking of air that way, then one has got numerical plurality and one is really thinking of the spaces between the bits as real. But if the spaces are real, then each one of them is air, so then how can the bits be bits? How can thought differentiate the bits or grasp their plurality? On the other hand, if the spaces are not real, then there are no bits either, and the fist has not got bits in it and the cream cheese has not got bits, so that the possibility of explaining their relative hardness has been ruined. In sum, Anaximenes assumes bits of air separated by spaces large or small that must themselves be qualitatively different from air, so that the assumption that everything that exists is air is contradicted.

Anaximenes did not see something: that if reality is really a single stuff it cannot be qualitatively different nor numerically plural. Or, as a philosopher might say, he is under the impression of being a monist and establishing a monistic thesis, but he talks like a pluralist. He is really an atomic or quantum thinker, only he does not know it.

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Let us try to see the same thing with respect to change. If a hard piece of butter melted and became soft, Anaximenes would explain the change by saying that a quantity of air which occupied at first a small space got rarefied so as to take up a larger space. But this makes sense only on condition that we think of the butter as consisting of bits of air with small distances between them that have been made bigger. But that means that we are supposing that something different from air is also reality, namely the distances separating the bits of air in the first place, and, in the second place, the parts of space required to be added to these distances to make them bigger.

What was Parmenides' conclusion? As already noted, he accepted the presupposition that everything there is the same, so his conclusion was that what is said descriptively about reality cannot be allowed to imply or suggest any differentiation in it whatever, whether in space (coexisting variety) or in time (change). As a philosopher might put it, the only kind of true assertion about it allowable was for him an analytical proposition, a proposition that attributed to reality exactly what it was called, or, as Parmenides himself put it, "That which is is." This may sound mysterious, but it means no more than that reality is a solid, unlimited, and motionless continuum, so that apparent variety and apparent change cannot, as the Ionian physicists imagined, be explained by means of it. If reality is one and if it is water, then it cannot change into or become anything but water, which, of course, is not really a change at all. If reality is one and if it is claimed to be water, or The Indefinite, or air, then it cannot have anything alongside of it, or behind it, or above it, or in front of it, or around it, or inside of it, which is different, so that Space, as distinct from it, and variety and multiplicity, must be denied at one stroke. Nor can it have anything before it, or contemporary with it, or after it, which is different, so that Time, as distinct from reality, and therewith change, must also be denied at one stroke.

What, if anything, commends all this? The answer seems to be: logic. Parmenides could say that he had understood what the assumption made by the Ionian physical thinkers required and he could claim consistency with that assumption, whereas they could not. Consider Anaximander. He had argued that earth, air, fire, and water separated out from the vortical motion of a

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pristine mass that was undifferentiated. But (1) how could there be motion unless there was space as well as the pristine mass, and how could there be space if all reality was the pristine mass itself; and (2) how could earth, air, fire, and water separate out from the pristine mass unless the pristine mass was undifferentiated merely because earth, air, fire, and water were in it in some sort of very fine and even distribution that the vortical action changed? Imagine you were looking at such a mass. You could not discern or discriminate a miniscule particle of water juxtaposed to miniscule particles of earth and air and fire. But the problem is a conceptual and logical one. Conceptually, Anaximendes' effort derives an apparent variety from an unapparent real variety and involves an unconscious inconsistency. But what about our experience of variety and change? Parmenides' answer is: they cannot be real, they are just how the world appears to us, not what the world is. If reality is single, then appearance, which is plural, is not reality.

The upset and possibly enraged reader should surely say at this point that science always takes its cue from experience and that experience is not an illusion for it. But Parmenides did not overlook this matter. It is the physical scientists he criticized that had produced theories to flesh out the assumption that the world is constituted of a single stuff despite appearances to the contrary. They could not find exception with his assumption, for it was the same as theirs. But they could not find exception with his logic either. One might say that Parmenides had discovered what any of the physicists we have reviewed might have discovered had they been logically selfconscious about their enterprise rather than wholly absorbed in it. As we shall see, subsequent physicists got the idea quickly and made use of it by changing the basic assumption in the manner in which Parmenides had given indication of its needing to be changed if they wished to appear rational in continuing their effort to find a theory of reality that explained appearances.

The Scientific Dilemma and Its Resolution: Atomism.

We have seen that in Ionian physics there was an unconscious tendency to quantum and pluralistic explanatory thinking side by side with a conscious effort to explain all physical phenomena

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as functions and derivatives of a single substance. We might say that this physics was an example of consciousness of the world in a self-unconscious way, an example of attention to phenomena with good logical conscience owed to behavorial self-unconsciousness. In contrast, the physicists after Parmenides, not as logically innocent, had to make a decision: (1) to try to do what Parmenides had shown could not be done and continue attempting to derive multiplicity and change from a single stuff supposed to be reality; (2) to give up trying to explain multiplicity and change and agree that these are subjective appearances; or (3) scuttle the assumption that a single stuff constitutes reality. Only a stupid man would do the first; only a person disposed to be content with the logical criticism of science would do the second. As a matter of fact, all of them did the last. These thinkers were Empedokles, Anaxagoras, and Democritus. For our purpose, we do not need to consider them all, so we shall review the physical theory of Democritus, who came last, since he appears to have been the thinker most clear in his mind about the postulates he needed to make explicitly to be invulnerable to the criticisms of Ionian physics that Parmenides had made.

One could say that Parmenides had insisted that the postulate that everything is the same requires that the existence of Space be denied, or one could say that it requires that Space be filled with all there is in it and indistinguishable from all there is in it. Parmenides appears to have expressed himself in ways that make him amenable to both interpretations, but it makes no difference. In either case, it follows that reality is motionless and undivided, literally homogeneous and a continuum both spatially and temporally. Accordingly, Democritus postulates five things: (1) that Space exists, (2) that minimal undividable bodies, i.e., atoms, also exist, these being in Space and distinct from it, (3) that the atoms differ from one another only in shape and volume, (4) that the atoms were never created and can never be destroyed or changed in any way intrinsically, and (5) that the atoms are constantly in motion. One might think of Democritus' view in this way: suppose one took Parmenidean reality and put it into a box greater in volume than the volume of Parmenidean reality, and suppose this Parmenidean reality were smashed into bits themselves not further smashable thereafter, one would then have the picture of reality that Democritus postulates. Of course,

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if the features of Parmenidean reality are recalled, supposing it to have limited volume and to be smashable or dividable is simply conveniently forgetful of the fact that Parmenides denies a distinction's being possible between reality and Space, so that this picture of Democritus's view in terms of Parmenidean reality is a loose way of speaking. Everything turns importantly on the claim that Space exists as something distinct from matter in it.

But now consider the results. No atomic bit ever changes in itself since none can ever be destroyed. The world, atomically speaking, is never new or different, since no atom is ever created (and none is dented, compressed, scratched, etc.). Nevertheless, there can be change, only this change is never a change intrinsic to any atom, but always a change in an atom's external relations, its relations in space to other atoms. Consequently, apparent changes are always changes in the appearances of molar objects whose constitution is atoms that are unchanged and unchangeable. The atoms can influence one another dynamically by impact, and molar objects have appearances (i.e., we see, hear, smell, taste, and feel them) because their constitutent atoms affect us by their impact upon us. Note: an atom by itself has no appearances, it is too small to make a significant impact upon us by itself. Enough atoms must have impact upon us together or there can be no perception: only then, what we perceive is not atomic reality, either individually or in aggregate, but rather a change in our own condition which is the effect in us of the impact of a collection of atoms in the world with atoms constituting our own bodies. Thus, Democritus provides a theory that is a compromise with Parmenides. Reality, which is atomic, is undifferentiated qualitatively and never changes. It is only appearance which is differentiated qualitatively and which seems to change, and appearance is not reality. Reality is correctly described atomically, not phenomenally, but it can be described atomically so that phenomenal change and variety can be connected with atomic reality and explained by means of it.

The boldness of this theoretical move by Democritus, and its significance, should not be underestimated. We said before that everything turns importantly on the postulate that Space exists as something distinct from matter in it. Since Democritus' name for Space, like the name used by Parmenides and other Greek

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scientific thinkers at this time was The Nothing, The Void, or That-Which-Is-Not, this postulate made him appear to his scientific contemporaries to be literally claiming somethingness for nothingness or existence for the non-existent. There is something in this move like the readiness of late 19th century physicists to impute apparently contradictory properties to the aether because planetary and electromagnetic phenomena did not appear to be capable of explanation otherwise, or like the readiness of more recent physics to postulate the matter of light to be continuous and discontinuous at the same time despite logical difficulties. Now why does Democritus do this?

Consciousness In Science and In Philosophy.

The answer seems to be that scientific consciousness tends to be consciousness disposed, like the consciousness of the ordinary man, to deal with the world and its contents and to provide itself with whatever ideas it must have for doing so. In other words, Democritus cannot settle, as Parmenides can, for an answer that is really nothing but *information about the nature of one's questions and one's presuppositions about the world and the logical limits that these questions and presuppositions generate.* He is interested in apparent variety and process in the world, and since Parmenides had shown that the central assumption made by previous physicists did not permit this variety and change to be taken seriously, he has decided to scuttle this assumption and to make a new assumption that does permit one to take these things seriously. Parmenides had raised questions damaging the viability of the new enterprise, physics. Democritus makes the emendations in assumption necessary for the effort to explain variety and change to be viable again. His success is not complete. It is still unclear how That-Which-Is-Not can, as Democritus postulates, exist or be something real, but the main point which Parmenides' critique in effect had made, namely that its existence in addition to some sort of stuff is required so that phenomena might be explained, has been met.

The relation between Parmenides and the pluralists Empedokles and Anaxagoras is similar to that between Parmenides and Democritus. Their pluralism is comprehensible only as a com-

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promise reflecting the influence of Parmenides' critique of Ionian science. Continuing the Ionian tradition, Empedokles and Anaxagoras assume that the world is simpler than its appearances might make a person think, but they do not try to deduce heterogeneity and change from a single homogeneous substance. Instead, they try to deduce phenomenal heterogeneity and change from heterogeneous material which they postulate to be miniscule and unapparent and to be present in molar objects in variable proportions. They assume that Space exists, since they postulate that fundamental or elemental matter is subject to motion (hence the *variable* proportions of heterogeneous materials constituting a molar object), but they differ from Democritus in that they do not appear to be consciously and knowingly assuming this, since they do not mention Space or explicitly claim existence for it in addition to the heterogeneous elementary material for which they do claim existence.

Earlier it was remarked that what Parmenides had shown is what any of the physicists criticized by him might have discovered, had they been self-conscious about their enterprise rather than engaged in it. This seems to be a typical difference between the philosophic mind and the scientific mind. The philosopher tends to think so as to identify and disclose the *a priori* ideas latent in the practice of science, whereas the scientist tends mainly to be governed by such ideas and to apply them, that is to say, build a structure of knowledge upon them. The philosophic mind tends to put a premium on logical impeccableness, meaning, and clear understanding, so that thought itself tends to be its subject-matter and logical analysis its method. The scientist tends to put a premium on the uses of ideas relative to his engagements with phenomena, and tends not to come to rest until the ideas he uses have seemed to him to have been enabling him to understand phenomena; his subject-matter is the world and, though he cannot ignore logic, experience commands his ultimate loyalty. This puts the philosopher in the position of pure conscience which men bent on dealing with actual affairs cannot help hearing, but which they cannot ever entirely satisfy. This is why Democritus and the ordinary man generally, closer to the man of action than to the man of thought, must be arbitrary somewhere and must be willing to begin with ideas that are somewhat vague and beliefs (presuppositions)

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whose claim to truth is not plain. Finally, as strange as it may sound, this is why science can be said to be closer to religious feeling and faith than philosophy, for science without some residuum of beliefs held dogmatically or uncritically seems to be impossible, whereas philosophy, as in the example of Parmenides, seems to be committed to total and self-inclusive understanding at the risk even of appearing to flirt with paralyzing paradox.

PYTHAGOREAN PHYSICS AND ZENO

Rationale of The Paradoxes of Zeno.

The paradoxes of Zeno the Eleatic may fairly be counted among the most remarkable productions of the human mind for the challenge and fascination they have made men feel, and for the thousands of pages of exposition, commentary, and refutation they have excited. The majority of students of them have interpreted them as intended to support categorical denials of Space, Time, and Motion in the world, and equally categorical denials of the validity of common experience. We see small and large objects in juxtaposition or small objects become large and large objects become small, but Zeno seems to say that what we see cannot be so. Everyone has observed an arrow or a stone traverse a distance, but Zeno seems to say that such phenomena do not really take place because it is logically impossible for them to take place. Achilles is surely swifter than a tortoise and would overtake it in a race, but Zeno seems to deny this. One hour's time is surely half of two hours' time, but Zeno seems to say they are the same.

Criticisms of the paradoxes have ranged from imputations of verbal sophistry and mischievousness to arguments that solving the paradoxes required mathematical resources which the Greeks did not have, namely calculus. All of these criticisms, however, are misdirected in that they fail to note that Zeno's paradoxes are logical criticisms of the foundations of Pythagorean physics and are meant to demonstrate that these foundations, far from enabling physics to explain phenomena, cause the statements of physics to be incoherent instead. Zeno's paradoxes are not, then,

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categorical denials of Space, Time, and Motion, but clarifications of some logical consequences of the concepts constituting the foundations of Pythagorean physics, so that a successful refutation of Zeno and a successful defense of Pythagorean physics are but two sides of the same task. As they do not say or show anything about the world, appeal to experience either to substantiate them or refute them is not called for. Nor do they challenge common sense or call for a defense of common sense. Rather, they propose to show something about certain scientific talk about the world that contemporaries of Zeno who were engaged in this scientific talk did not have the logical self-consciousness to realize.

Numbers As The Elements of The Physical World.

The physicists whom Zeno attacks were pluralists of the 5th century B.C. who were followers of Pythagoras, who lived in the century before, and who appear to have been prompted to modify some of the ideas of their master by the theory of elements of Empedokles. Empedokles had maintained that there were four kinds of elementary matter, earth, air, fire, and water, that molar or phenomenal substances were mixtures of these kinds of matter in different proportions, and that the properties of molar substances depended on what the proportions were and on motions that made the proportions subject to change. Pythagoras had held that objects in the universe had likenesses to numbers and were to be understood after their likenesses to numbers. The new Pythagoreans of the 5th century, adapting these two ideas, took the position that numbers were the elements of reality and that phenomena, and the relations of phenomena to one another, were to be understood in terms of suitable numbers and the relations of these numbers to each other.

The nature of the adaptation involved here is possibly best understood in terms used by an early expository source:

> "From numbers points, from points lines, from lines plane figures, from plane figures solid figures, from these sensible bodies of which the elements are four: fire, water, earth, and air. These change and are wholly transformed; and from them arises a cosmos..." [3]

[3] Diogenes Laertius viii. 25 (Diels-Kranz, *Die Fragmente der Vorsokratiker*. 58 B 1a, Berlin, 1954).

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It is plain that the substances which are called "elements" in this passage are the elements of Empedokles and that the innovation made by the Pythagoreans after Empedokles was to give these substances the status of compounds constituted of other elements more suited to their own mathematical point-of-view, namely points in space. The position becomes clearer when it is realized that it was the practice of these Pythagoreans both to represent and to classify arithmetical quantities (numbers) in a geometrical way, just as if arithmetical quantity and geometrical magnitude were isomorphic and even interchangeable. Thus, one dot stood for the number "one," two dots stood for the number "two," three dots for the number "three," and so on. Moreover, numbers were classified as linear, plane, or solid. For example, the number "two" was linear because it took two points minimally to define the line; "three" was a plane number, and moreover a triangular number, because three points define the limits of the plane with the smallest number of sides; "four" was either a plane number or a solid number depending on whether the four dots required to represent it graphically were disposed so as to lie in the same plane (yielding a quadrangle) or three dots on the same plane and one dot outside (yielding a pyramidal shape). The system was elaborate and the student who goes into the details of it will find that the Pythagoreans fully deserve their reputation for having invented number theory and for significant advances in it.[4] Our purpose here is to give the barest details necessary to illustrate the Pythagorean tendency to think of the arithmetic quantity, starting with the number "one," as a geometrical magnitude, and possibly to materialize it, as if it were a physical atom. The point, on this view, was but the arithmetic unit "having position," and different numbers that are multiples of the number "one" were appropriate for representing solids, planes, and lines because the latter tended to be considered as owing their magnitude to their being multiples of the point. This is why, as Professor Burnet points out, it seemed possible to the Pythagoreans to construct the world "out of such elements."[5]

[4] Cohen and Drabkin, *A Source-book in Greek Science*, New York, McGraw Hill, 1948, pp. 5-24.

[5] J. Burnet, *Early Greek Philosophy*, London, Adam and Charles Black, 4th Ed., 1948, p. 290.

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The supreme importance of the general view of the Pythagoreans is easy to see from the history of science later, particularly from the 17th century which saw in Galileo, Kepler, and others an impressive renaissance of the practice of finding mathematical terms, models, and expressions for representing physical phenomena. It is worthwhile noting in passing, however, that already, in Greek science, philosophical problems that remain sticky to the present day about the *point d'appui* in physical entities of concepts that are purely mathematical had commenced to appear. Democritus, the atomist whose theory was discussed in the previous section, puts a question that illustrates this dramatically:

> "If a cone is cut by a plane parallel to its base, how are we to think of the surfaces of the sections? Are they equal or unequal? For if they are unequal they will make the cone uneven, for the cone will have many steplike indentations and roughnesses. And if the surfaces are equal, the sections will be equal and the cone will obviously have the properties of the cylinder, for it will consist of equal circles. Yet at the same time it will be a cone consisting of unequal circles." [6]

Democritus' problem, as stated here, appears to be generated exclusively by logical considerations bearing on how "cone" and "cylinder" are defined, but it is hard to believe that Democritus is not also showing uneasiness about the prospect of coherent empirical applications.

The Paradoxes.

Zeno's paradoxes appear to be many different ways of insisting that the unit be clearly defined and that the notion of an object's being a sum of discrete units be made coherent. The reality of observed things, and of happenings in which these things are involved, are alleged by the Pythagoreans to be derivative or secondary, that is to say, a function of the reality of units that are constitutive. Accordingly, Zeno is quoted in one early source

[6] Cohen and Drabkin, *op. cit.*, Footnote 3, p. 70.

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as having said that "if anyone could tell him what the unit was, he would be able to say what things are."[7] Some of the paradoxes follow.[8]

(A) *The unit and magnitude.* It would seem that the unit must have magnitude, else how could the multiple of the unit—the line, the plane, and the solid—have magnitude? But if the unit has magnitude, why should we take it to be a unit and not itself a multiple? If the unit has magnitude, then it would be divisible into parts that themselves have magnitude, and these again into other parts that themselves have magnitude, and these other parts again divisible into still other parts *ad infinitum.* Why should this stop, and if it does not stop, what *use* and what *meaning* does the postulate of the fundamental unit have? Everything real becomes a multiple, nothing whatever can justifiably be called the unit, and anything called small ought really to be called very great.

It might be imagined that all these difficulties would disappear if we took the opposite alternative and said that the unit had no magnitude. But then other difficulties would arise. If the unit had no magnitude, then, if a unit were added to a magnitude, say a line, the magnitude would not be made greater than it was, and if the unit were subtracted, the magnitude would not be made less. Moreover, anything great ought really to be called very small. And, indeed, it is impossible to see why the line, the plane, the solid, should have magnitude when they are supposed to be sums of units which have no magnitude.

(B) *The unit and space.* If it is insisted that ultimate reality is the unit "having position," as the Pythagoreans appear to do, then the Pythagoreans have to say that Space is real, and they have to say that this is due to Space's being a unit or a sum of units, which is the same as saying that space is in space or that space is real because there is space that contains it. But then this containing space must be real because other space contains it, and this other space again is real because still other space contains it, and so on. This seems to be absurd, and it seems that to avoid absurdity the Pythagoreans have to say that there is no space. Of course, if there is no space, then, whatever reality is,

[7] J. Burnet, *op. cit.*, p. 315.
[8] *Ibid.*, pp. 315-320.

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it has no parts in fact or in principle, and it is nonsense to say anything is a sum of units or a multiple of the unit.

(C) *The unit and motion.* Take a certain distance constituting a race-course. Surely a runner must traverse half the distance before he traverses the whole distance, and before he traverses half the distance, he must traverse half of this half, and so on again *ad infinitum*. Now, no matter how fast the runner runs, he cannot cross the race-course because, in order to do so, he has to pass an initial unit which itself is an infinite number of units, the initial one of which is also an infinite number of units, etc. This paradox assumes that the Pythagoreans suppose the units constituting a distance to have magnitude, to which, the thrust of the first paradox (A) is then applicable.

The famous Achilles paradox differs from the race-course paradox in that another object moving in the same direction, namely the tortoise, determines the point to be reached, so that when Achilles has traversed the original distance, there is an increment of distance he still has to go, and when this increment of distance has been covered, there is still another smaller increment, and so on *ad infinitum*, so that Achilles is always getting nearer to the tortoise but never catching up to him. Like the previous paradox, this paradox demands satisfaction that the Pythagorean concept of the unit is distinguishable from the Pythagorean concept of the multiple of the unit. It demands satisfaction that the concept of the unit relied upon is logically coherent.

The Stadium paradox, which is the last we shall consider, is the most complex of the paradoxes and deserves special attention. It goes like this:

> Half the time may be equal to the whole time. Let us suppose three rows of bodies of equal size and disposed at the beginning of a time interval as in Fig. 1, where the A's are stationary and the B's and C's are bodies moving with equal velocity in opposite directions. By the time the rows are disposed as in Fig. 2, B will have passed twice as many bodies in C as in A. Therefore, the time taken by B to pass C is twice as great as the time taken by B to pass A. On the other hand, the time taken by both B and C to pass A is the same. Therefore, the whole time and half the whole time are equal.[9]

[9] From J. Burnet, *op. cit.*, pp. 319-320, with some rephrasing for clarity.

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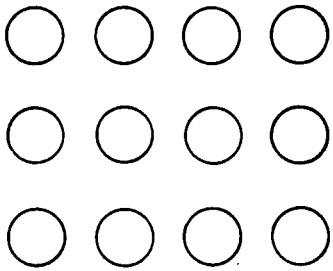

FIG. 1

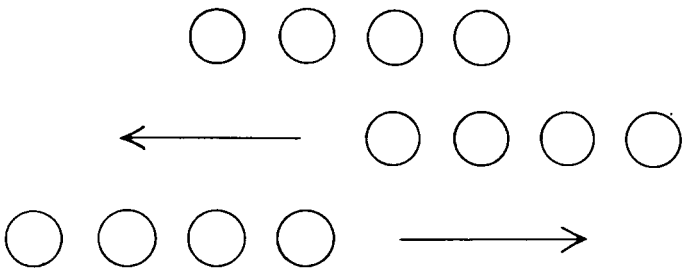

FIG. 2

To see the drift of this paradox clearly, it may be profitable to see the paradox as offering three alternative ways of thinking of the motion of B, considered as a linear magnitude equal to A and C considered also as linear magnitudes.

> (1) B - moves different distances with the same velocity in the same time (with the same velocity it moves two units of distance in A in the time that it moves four units of distance in C).
>
> (2) B - moves the same distance with different velocities at the same time (in the same time it moves two units of distance in C with twice the velocity that it moves two units of distance in A).
>
> (3) B - moves the same distance with the same velocity in different times (with the same velocity it covers two units of distance in C in half the time that it covers two units of distance in A).

Now none of these statements can be true because every one of them is self-contradictory. The same motion of B cannot be motion that traverses two different distances, it cannot be motion

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with two different velocities at once, and it cannot be motion taking two different times to transpire.

It is important to note that the reader will simply have missed the point if he says that all of these statements are true about the motion of B *relatively* to A and C. It is not denied by Zeno that appearances admit contradictory descriptions (the stick half submerged in water and bent relatively to sight *is* at the same time straight relatively to touch). What is denied is that any of these statements can be true of *reality*. Zeno's purpose is to prove the incoherence of the Pythagorean theory of reality, in the first place, and its unsatisfactoriness for providing a coherent explanation of phenomena or appearances, in the second place. Nor should the reader say that Zeno's argument contradicts "common sense," since Pythagorean pluralism is not what "common sense" shows. As observed earlier when Anaximenes was being discussed, the "obvious" is not truth for science and the distinction between appearance and reality is central for it, or scientific investigation would not be needed to find what the truth about the world is. The issue throughout all of the paradoxes of Zeno has to do with the satisfactoriness and explanatory adequacy of the Pythagorean frame-of-reference for saying what reality is as distinguished from its appearances. The Stadium paradox is meant to show that the Pythagorean frame-of-reference requires the "real" motion of B to be described in one of the three ways above and that, as every one of these descriptions is self-contradictory, it must be denied that any of these descriptions is a description of reality. And, in general, Zeno's point is that if primary motion cannot be admitted with logical coherence, then secondary or relative motion cannot be admitted either.

Parmenides and Zeno.

Traditional historical accounts have it that it was one of Zeno's purposes to defend Parmenides, who had denied variety and change, against Pythagorean critics charging that Parmenides' view conflicted with common sense and boasting that their own view did not. With this in view, it might fairly be said that Zeno's point is that, while Parmenides' denial of plurality and motion contradicts common sense, it is not guilty of logical absurdity, whereas Pythagoreanism denies common sense and is commited to logical

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absurdities as well. To go further, however, and take the position, as many historians have done, that Zeno *shared* the view of the Ionian physicists and of Parmenides that reality is single and homogeneous, may be a mistake, since it overlooks the probability that Zeno was scientifically neutral, preferring to abstain from making any assertion whatever about reality and to limit himself strictly to logical analysis and criticism of such assertions. That there is such a probability is implied in Zeno's reputation as the "inventor of dialectic," the art, as Aristotle characterized it, of arguing, not from premises that one believes oneself and is prepared to claim truth for, but simply from premises admitted by the other side to the end of clarifying them and testing where they lead. The suggestion being made here is that, although Zeno and Parmenides were evidently both philosophers rather than scientists, they were philosophers in two different ways that have become traditional, and that one of these ways is philosophy that tends to be completely and self-consciously analytical and clarificatory whereas the other way is philosophy that actually serves the same function while under the mistaken impression of making assertions and discoveries of a scientific nature (i.e., discoveries about the world). This will be explicated more fully in the next section.

SCIENCE, METAPHYSICS, AND PHILOSOPHY

Parmenides and the World.

It surely does seem possible to say that Parmenides did not only subject Ionian physics to an analysis that disclosed a radical inconsistency between its central assumption and the explanations of physical phenomena advanced by it. Having considered the central assumption of this physics, he evidently accepted it and proceeded further to advance *as discoveries about the world* the theory of reality and of the cognitive worth (or worthlessness) of experience which he had shown this assumption to require logically. On the other hand, he has been represented in these pages as if his subject were the language of Ionian physics rather than the world meant by physicists to be described by means of this language. We would seem obliged, therefore, to say that the

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ideas of Parmenides constituted both a criticism of science and a theory of the world, an exercise in the philosophy of science and an exercise in science or scientific description as well. How is this possible?

Self-unconsciousness in Philosophy.

This phenomenon is possible if it might be said of philosophy itself, in its inception and even throughout a large part of its history, that it has done one thing consciously and quite another thing unconsciously.

The characteristic attitude of science is external consciousness or heteroconsciousness; indeed, this is the characteristic and normal form that consciousness takes in most activity. If this is correct, then philosophers, while differing from most men in that their thought tends significantly to logical self-consciousness, should not be expected to escape the influence of the more fundamental animal tendency to heteroconsciousness, so that their ideas, although ideas of ideas in use, might tend naturally to find expression in an object-language such as scientists and other men use rather than in a meta-language which is the sort of language philosophers ought to use.

Metaphysics and Language.

Here Carnap's distinction between language in the material and language in the formal mode can be given a useful and illuminating historical application.[10] Metaphysical statements, such as Parmenides' claim that there is no Space or that Space is full, tend to be problematic about the sense in which they are true or false because philosophers have habitually expressed them as if they were statements representing discoveries about the world, or objects in the world, when they are really statements representing discoveries of beliefs, statements (explicit or implicit), and other linguistic units in use in science and in everyday life. A question like "What is the relation between mind and matter?" for instance, is puzzling because it seems to be a question about two

[10] Cf. R. Carnap, *The Logical Syntax of Language*, London, Routledge & Kegan Paul, 1959, pp. 297-315, and *Testability and Meaning*, New Haven, Whitlock's Inc., 1954, pp. 428-431.

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kinds of objects in the world that scientific recourse to experience might be relied upon to compare, that is to say, a material question. Changed into the question "What is the relation between the concepts (or language) of psychology and the concepts (or language) of physics?," that is to say, a formal question, the puzzle tends to be removed because it becomes clear that in order to answer the question a logical analysis of two languages, and not scientific observation, is called for. There is still a question about two kinds of objects, only it is a question about what we *mean* by those kinds of objects, a question for logical analysis and not a question for experiment to resolve.

We have seen the work of Parmenides and Zeno appear as something stimulated by antecedent science and this is noteworthy, since it is the opposite of the thesis historians have often advanced that philosophy preceded science and was the mother of science. We might add to this now that heteroconsciousness might have been expected to precede logical self-consciousness both historically and psychologicaly. And this might be put differently by saying that object-languages precede meta-languages, and that the distinction between object-languages and meta-languages is a distinction there would have been no provocative conditions for men to make without instances of historical (primitive or sophisticated) scientific discourse and philosophical discourse to compare.

The Presuppositions of Science as Beliefs of Scientists About the World.

The tendency of Parmenides to put his discoveries about Ionian physics as if they were discoveries about the world might be understood still better on another ground. The presuppositions of science are beliefs that scientists have about the world, even though it be true that they are not beliefs of scientists in the sense that scientific conclusions are considered to be beliefs of scientists. Accordingly, in his capacity as vicariously self-conscious scientist, a philosopher might understandably tend to express the presuppositions he finds in science as a scientist might do if the scientist were consciously instead of unconsciously commited to them, that is, the philosopher might express them as beliefs about the world or as factual descriptions. One might say that there is no reason for faulting the philosopher for this because, as vicariously self-

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conscious scientist, he is doing his job. Fault there is, however, in that only a philosopher unconscious of the fact that he has been vicariously self-conscious can advance as discoveries about the world beliefs that are only presuppositions for the discoveries that science makes. Kant saw this clearly when he took the presuppositions of Newtonian physics to be indicative of *a priori* conditions characterizing, not reality or the world, but the human mind, and in doing so he may be said to mark a major turning-point in philosophy's own development toward realization and full consciousness of what its task really is. At any rate, the point is that metaphysics is logical clarification that thinks it has discovered what the world has in it, it is philosophy that thinks it is science, it is meta-language expressed as object-language.

Autonomy of Philosophy and of Science: Duhem's Confusion.

The same line of reasoning holds the answer to Duhem's argument that historical science has been influenced by philosophical (metaphysical) schools of thought with prejudice to the autonomy of science.[11] For it is easy to see that the opposite can be argued, namely, that philosophy has been influenced by science, and especially by the presuppositions of science, with prejudice to its ability to achieve its own autonomy by learning to express the presuppositions about the world that it finds in science in the formal instead of in the material mode of speech. The presuppositions of science, as beliefs, that scientists have about the world, lend themselves most naturally to expression in the same language (the object-language) in which scientists express themselves. So expressed, these presuppositions constitute a metaphysics rather than a disclosing and clarification of metaphysical ideas that scientists have, so that philosophers rather than scientists appear to be the source of metaphysical ideas. Strictly speaking, therefore, the metaphysical ideas science has to fear are the ones it unconsciously holds, and its only hope of liberation from metaphysics is, as Duhem's own philosophical work shows, philosophy itself as an activity that is non-scientific and that, with or without consciousness that it is doing so, distin-

[11] Duhem, P., *La Théorie Physique*, Paris, Libraire Marcel Rivière, 2nd ed., 1914, Ch. 1.

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guishes for science its presuppositions from its discoveries and its logic from its content.

And this is consistent with philosophy's being the source of metaphysical ideas on occasion. When philosophical activity discloses that the practice of science is inconsistent with the presuppositions of science, or that the presuppositions of science generate intolerable paradoxes, the same activity might undertake to show or suggest new presuppositions (in effect, a new metaphysics) that *would* be consistent with scientific practice and that does not make intolerable paradoxes arise. It is easy to see that the influence of Parmenides on the Greek physicists who immediately followed him was of this nature.

Uselessness for Historiography of the Conception of Philosophy as an Attitude.

A primary consideration that has helped foster the historical thesis that philosophy preceded science has been the tendency to regard philosophy as an attitude, generally unformulated and unconscious, which underlies an activity or practice or institution and which must have had to pre-exist for the activity or practice or institution to exist. In reply to possible criticism of the opposite thesis of this essay on this ground, it cannot be emphasized too much that philosophy as an *activity* or *undertaking* distinct from other activities and undertakings is the subject of the historian of philosophy. (Evidently some philosophy or other in the sense of an attitude or unconscious world-view might well be implicit in a human undertaking without philosophy's being an undertaking itself.) Moreover, the origins of philosophy in the sense of attitude or implicit belief (about the world, knowledge, society, values, or whatever) would be hidden in the origins of human undertakings and, in particular, the earliest human undertakings. The first legal philosophy should have to be sought by historians of philosophy in the first instance of law, the earliest philosophy of art in the earliest or first instances of artistic behavior or aesthetic experience, the earliest philosophy of science in the earliest expressions of curiosity about nature, and so on. Nothing is more plain, however, on even the most casual inspection, that historians of philosophy do not write their histories with such

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a conception of philosophy in mind, that the 6th century B.C. is much too late a date to start with if this were their conception, and that it would be a *wholly separate task*, in any case, to identify the beginning of philosophy as an undertaking. In a word, philosophy in the sense of implicit attitudes and beliefs has little or no use for the historian of philosophy, and what is needed for history of philosophy is a clear idea of philosophy as an undertaking distinct from science and other undertakings.

These observations should be connected with the observations made earlier about the presuppositions of scientists as beliefs that scientists have about the world. The fact is that such presuppositions are not instances of philosophy or products of philosophy as an undertaking and do not require that there shall have been anything antecedently resembling philosophy as an undertaking. Philosophy usually functions so as to disclose what such presuppositions are, but this does not make such presuppositions constitute philosophy before anything like philosophy as an activity has taken place so as to disclose them and indicate their significance. The trouble with the conception of philosophy as unconscious attitude and belief is that it makes one's merely having any unconscious belief or attitude whatever the same thing as one's being a philosopher.

Uselessness for Historiography of the Conception of Science as an Attitude.

And, since we have had to deal with the beginnings of science as well as philosophy, similar remarks may be made as to the utility to the historian of science of the conception of science as an attitude.

It is scarcely surprising that even the most primitive peoples will be found to have a profane and secular attitude in regard to some objects and phenomena alongside of a magical attitude in regard to other objects and phenomena. As is well known, Malinowski and others have made much of this for saying that primitive peoples have science.[12] But one might as well on this account find significance for the beginnings of science in the

[12] Malinowski, B., *Magic, Science, and Religion*, Glencoe, Ill., The Free Press, 1948, pp. 1-18.

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expectations of regularity in phenomena evinced in the habits of animals generally. Such expectations may certainly be said to show a profane attitude, and the habits themselves might even be said to evince beliefs about orderliness in the world, but this would hardly justify one's saying that science is an aspect of animal life. At any rate, it needs no arguing that this is a very different thing from science as an undertaking distinct from other undertakings and that historians require a conception of science of the latter kind.

Conclusions.

Unless we are mistaken, therefore, the special function of philosophy, whether metaphysical or strictly analytical, has been the same since its inception as a human activity distinct from other human activities, namely, to discover, formulate, clarify, and explicate beliefs and ideas constituting the rationale of other human activities but normally not formulated, not clear, and not explicated.[13] The relations of the work of Parmenides and Zeno to that of the other so-called pre-socratic thinkers are especially valuable in that they provide a paradigm that is unprejudiced and clear respecting the relations of science and philosophy: (1) unprejudiced, because, since they did not work from a distinction that was known to them and that anyone had yet had any occasion to make between philosophy and science, they did not have a philosopher's axe to grind nor a scientist's axe to grind on the relations between science and philosophy; (2) clear, because they simply did something plainly different from that done by the other pre-Socratics which makes it possible to recognize the differences that are familiar to us now between philosophy and science in particular and philosophy and other human activities generally. It is these differences that we have found it most convenient and helpful to notice in terms of heteroconscious and self-conscious activity.

Drawing the general and special conclusions that are indicated

[13] "Let us look back and I think we shall find that the first philosophical phase, properly understood, was not so unlike the last and then that the last, properly understood, is not so unlike the first." — John Wisdom, "The Metamorphosis of Metaphysics," p. 50, Proceedings of the British Academy, Vol. XLVII, London, Oxford University Press, Amen House E.C. 4, 1961.

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and recapitulating, we may say, then, that philosophy is, and has been in history, a secondary activity or deutero-phenomenon, heavily characterized by self-consciousness and having for its subject-matter other activities that are primary, more vital, older and heteroconscious by comparison, such as art, religion, science, and politics. This implies that philosophy is not life but rather, as Plato makes Socrates say, the examination of life.

It follows from this that science is an aspect of heteroconscious life and that it is wrong both from a psychological and historical viewpoint to say that philosophy preceded it. The activities and ideas of the thinkers of the 6th century B.C. which we reviewed and with which all historians of science and philosophy begin, supported this in showing that all these thinkers, save Parmenides and Zeno, are best understood as primitive theoretical physicists and that we find in Parmenides and Zeno the first examples, on a scale conspicuous enough to be recognized, of what we should now call philosophy. Parmenides and Zeno each mount an analysis and criticism of some contemporary physical theory, the fundamental question this theory is concerned to provide the answer for, and the language in which both the question and the theory are put. Their subject was a scientific doctrine, and not (or only obliquely) the world on which scientific consciousness which produces such doctrines is wont to be focussed. Consequently, their effort can be called an effort in vicarious scientific self-consciousness, that is, an effort that a scientist would have had to be mainly self-conscious to make himself. The result, as we saw and might have expected, was not really a new scientific doctrine of their own, but the possibility of a new and better doctrine from subsequent scientists having on their predecessors the advantage of logical self-consciousness not possible before.

The merit of Parmenides and Zeno is that they appear to have been the first to have made this kind of intellectual contribution on a scale deserving to be marked historically. Zeno's paradoxes are pieces of reasoning that any Pythagorean physicist could have performed, and Parmenides' thoughts are thoughts that any Ionian physicist might have reached, provided the consciousness of these physicists had been directed at least as much on their own explanatory behavioristics as physicists as on the appearances and behavior of the external world of matter. This kind of

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consciousness, had they exercised it, would not by itself have led the physicists to success in formulating a theory of physical variety and change, but, as the work of Parmenides did for physicists afterward, most notably Democritus, it might have led them to understand the logical conditions that needed to be met for the viability of their effort.

Finally, in the light of the psychological frame-of-reference we have depended upon, it is not difficult to understand why the Ionian and Pythagorean physicists did not by themselves have the situational perception about their theories, their logic, and their language, that the work of Parmenides and Zeno enabled the successors of these physicists to have. The bias of the scientific thinker is a bias for action in the heteroconscious or realist mode. We saw this in Democritus' providing himself with new presuppositions so as to get on with the explanation of physical phenomena. The scientist wants knowledge about the world first of all, and not knowledge about the knowledge he is trying to build up. That philosophical works by scientists are exceptions, that a large majority of scientists have little or no interest in doing such work themselves and little or no interest in philosophical works generally, and finally the fact that scientists tend to be puzzled by such works and even suspicious of them—all these facts have one and the same explanation: the characteristic attitude of science and the attitude that mainly promotes science is external consciousness or heteroconsciousness. The attitude that mainly promotes philosophy, on the other hand, is logical self-consciousness. If we could imagine a community of eyes, the philosopher among them would be the eye that said it was the proper business of the eye to see itself. To the student and historian of philosophy, the Socratic precept is recognizable. Philosophy is not illuminating about the world. It is illuminating to man about himself as reflected in his non-philosophical activities. It is a mode of consciousness that is utterly self-serving and that reaches for self-inclusiveness approaching the self-justifying consciousness that both Aristotle and Spinoza supposed that Deity must have.

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