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Aristotle's Physical World-Picture: An Historical Approach

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(Note by the Program Committee: It is with great regret, that to bring the reproduction of Professor Solmsen's paper within manageable length, we have been compelled to omit the first 13 pages of its valuable introduction. In the course of it the writer points to the chasm between Aristotle's concept of the physical world and that of the Presocratics, and urges the recognition of Plato's Timaeus as "at least a firm half-way station in our voyage across the large chasm." The most important of the points at which, the writer holds, the Timaeus serves as such a "half-way station" is what he calls Plato's "rehabilitation" of the concept of genesis, rejected by the Presocratics under the influence of Parmenides. Aristotle takes up where Plato leaves off, "is anxious to clarify the relation between Becoming and its Presocratic substitutes, and also to distinguish it once for all from the concept of qualitative change, yet sees little need to reestablish Becoming itself as a valid concept, "because this had already been done by Plato. The discussion of this point leads up to the closing paragraph of the Introduction with which the reproduction of the paper (with no subsequent cuts) now begins:)

As we all know, Aristotle bestows a good deal of care on explaining disagreements between his own and other philosophical positions and is much less careful about indicating agreements. He does not often point out that a philosophical or physical subject has been thoroughly transformed by Plato and that he himself attacks it on the new level and under new conditions of inquiry--to say nothing of new methods--for which the credit should go to Plato. Thus it remains for us to identify the central areas in which his debt to Plato is paramount--and at the same time, if still necessary, to prove the existence of this debt. I should like to draw attention to three such areas. I: The subject of movement (or change) has been given an entirely new status: II. Cosmology and in particular the doctrines relating to the place of the elements in the Cosmos have been deprived of their traditional, i.e., Presocratic basis and must be established on different foundations; and III. The concept of genesis which Plato has brought back must be developed in such fashion that it may cover the

origin of the four elements out of one another, as well as the formation of compound substances. We shall now proceed to consider these three subjects in some detail.

I.

Parmenides had shown no more mercy to Movement than to Becoming, but had not been equally successful in eliminating it from philosophical discussion. The physicists who came after him could construct their systems without employing the tabooed concept of genesis but found it impossible to dispense with Movement and physical changes. Thus in the history of Physics Plato's recognition of Movement is perhaps not as revolutionary a step as his rehabilitation of genesis, yet it signifies an important reorientation of his own thinking. Moreover, the form which this recognition took was bound to have far-reaching consequences. For Plato in effect makes the concept of Movement the most general denominator of the entire realm of physical processes: "There is every necessity for the philosopher who values (knowledge and the like) above all else.... He must declare that Reality and the sum of things are both at once--all that is immovable (changeless) and all that is in motion (change)."(10) This sentence of the Sophist may be regarded as a kind of program--and as a program which is implemented inasmuch as almost every late dialogue (from the Theaetetus to the Laws) contributes something to the elucidation of the subject which has here been established in a central position. In this paper it is impossible to review these contributions; we must content ourselves with referring to certain aspects of the subject that emerged when it came under intense philosophical scrutiny. I have said that all physical changes are comprehended under the heading of Movement; yet it is well to remember that Plato announces his recognition of Movement in the same group of dialogues in which he also prepounds his new method of logical or ontological division, the dihairesis. Thus we cannot be surprised if the genus Movement--let me call it thus, for reasons of convenience--is no sooner incorporated into his system than it becomes subject to this rather imperious method and finds itself divided into a number of species.(11) In the Laws Plato distinguishes ten "forms" of Movement (or Change); locomotion alone-- which always receives particular attention--is represented by several such forms; there is also growth and decline; there is passing away and indeed coming to be--though it seems that the close intrinsic connection which Plato establishes between the other forms

breaks down when he comes to this. Qualitative change is absent from this list, but we should recall that already a somewhat earlier dialogue, the Theaetetus, has suggested a division of all movements into locomotion and qualitative change. The Academic division of Movement may not have been rigidly fixed, yet the mere attempt to distinguish a number of different forms and to study the relations between them is something that would have overtaxed the logical equipment of the Presocratics, for whom it sufficed if physical entities that find themselves in movement are brought together, mix, and after a time again break away from each other. That Aristotle owes a profound debt to Plato's logical efforts need not be demonstrated at length. He knows the same "species" of Movement. In fact, he not only recognizes locomotion, qualitative change, growth and decay, Becoming and Passing-away as the basic "forms" of Movement, but also accepts the distinction between self-caused movement and movement springing from an outside source--a distinction which was to prove as helpful to him as it had been to Plato in providing a foundation for his theology.

It is implied in what has just been said that the relation which Plato had set up between his various forms of movement were not exclusively of a logical order. He is also interested in what one may call their physical interconnection; he finds physical continuity and a pattern of cause and effect between the different species. To put it somewhat crudely, all other changes presuppose local movement and are brought about by it. In the causal interconnection of changes locomotion must have the first place. We may ignore the somewhat dubious evidence of the Theaetetus in which the coming into being of everything is traced to movement on the part of the percipient and simultaneous movement on the part of the perceived object, and may by-pass a goodly number of statements that are scattered through the later dialogues. Let us concentrate on two passages: The list of movements in Book X of the Laws begins by enumerating various types of local movements and then goes on to show how bodies engaged in such movements meet others, which meeting leads to mixture of their substance, to loss of material or to accretion of new material, i.e., to growth and decline, also it would seem to passing away, yet not--in this account--to coming into being, which is something more fundamental and must be approached from a different basis. (12)
Now if we turn to the other passage, in the Timaeus, which explains how movement is set up between the elements in our Cosmos, we find all movement of the kind traced to the rotation of the outermost Heaven, which forces the elements to

struggle with one another in a confined space, to move across one another, and thus causes the breaking up, the coalescence and new formation of elementary particles. The rotation of the Heaven is a manifestation of Soul, which in Plato's scheme is the principle of self-motion, and as such the origin and cause of all movements and changes. The changes which it is here said to cause clearly include--as Cornford has not failed to recognize--the transformation of one element (like air) into another (say water). And the coming to be of one element out of another is indeed genesis. Here, then, we have genesis causally related to local movement; it is simply one of the changes and has no place of honor among them. Still, to realize that this is not Plato's only approach to genesis, it will suffice briefly to recall what he says in the section on the Receptacle. There genesis is brought about by the action of the Forms on the Receptacle. The process of Becoming is sui generis and autonomous, in no sense whatever an adjunct to Movement. We are here on a totally different plane of philosophical thought. Such movements as are mentioned in this section, to wit, the drifting to different places of the elements in the Receptacle, are obviously subsequent to genesis, and presuppose it.(13) It is, as a matter of fact, not difficult to understand that Plato could treat Becoming as a kind of movement and yet again in a different context as something prior to movement and existing in its own right. His own system, as well as the previous development of physical thought, provides ample justification for this dual approach.

The situation here sketched continues in Aristotle. It is reflected in his terminology, in his theory, and even in the general orientation of his physical system. Sometimes he includes coming into being among the movements, sometimes he sets it apart from them. When he treats the movements jointly in the Physics he at times comprehends genesis in them, at times thinks only of local movement, qualitative change, and growth of decline. When he treats them separately and with emphasis upon their differences, as in the treatise On Coming to be and Passing away, his very effort to establish clear-cut distinctions especially between coming-to-be and qualitative change, shows that they are for him members of one and the same family. This impression is confirmed by the parallels which he incidentally draws between, e.g., the factors operating in genesis and in local movement, yet more important than any of them is the parallel direction of his argument in the chapters on growth and on genesis. In both instances he establishes the "organic" nature of the process, destroying the traditional notion that it can be understood as a mechanical-quantitative

addition of material. Moreover, in the Physics, the "rivalry" between Movement and genesis becomes acute when Aristotle wonders whether local movement or genesis should be considered the first "movement."(14) In a certain sense, he admits, genesis has a claim to primacy, yet his final decision is in favor of the view that genesis cannot take place unless there is a prior local movement. The local movement which he has in mind is again, as in Plato, a cosmic, more precisely a celestial, movement, the approaching and receding of the Sun (on which he says more in this sense in the treatise On Coming into Being.) I n the Physics he not only traces all movements to local movements but also, like Plato, all local movements to their first source--to a first mover and a first moved, which he insists must be regarded as distinct. It is legitimate to say that by defending the primacy of local movement he preserves the Presocratic pattern as well as the Platonic (on which he directly depends); for in the later Presocratic systems, too, Movement is the prior condition to all physical changes and formations, though surely the first movement has now been raised to a status and dignity of which the Presocratics never dreamed. It is contiguous to the deity and to the highest form of Being (this was the condition on which Plato had incorporated Movement into his physical world-scheme).

The rehabilitation of genesis which Plato had begun is by Aristotle carried to its conclusion. In the treatise On coming to Be--probably his last word on the subject--Coming-to-be is set up in complete independence and with definite characteristics of its own.(15) However, the last chapters once more return to the alternative point of view by showing that in this Cosmos all coming-to-be and passing away is causally related to the movements of the Sun. In other words, the thorough-going revision of the details has left the fundamental situation unchanged. The dual approach to the relations between movement and genesis is as characteristic of Aristotle's system as it is of Plato's. It has only become more conspicuous.

The trend of our argument may suggest that the theory of Movement which Aristotle gives us in the latter books of the Physics is much closer and owes a much greater debt to Plato than to the cosmological speculations of the Presocratics. By and large, this conclusion would be correct and if we regard these four books as a unit--which is entirely legitimate, since their incorporation into the Physics is secondary--we may even maintain that in none of Aristotle's other scientific works is the distance between his own thought and the original interests of the Presocratic thinkers as great as it is here. The high level of abstractness or better, perhaps, of generality on which Aristotle here operates

would in itself constitute a strong argument in support of this contention. To treat the different species of movement jointly, to investigate their common characteristics, and to scrutinize all that belongs to the concept--and to the physical fact--of Movement are intellectual enterprises that would never suggest themselves to the Presocratics and that presuppose a logical equipment which they did not possess. Moreover, close contact with Plato, in fact closer contact than is generally allowed, may also be discovered in important details of his doctrine. Thus, for instance, when Aristotle at the beginning of his discussion embarks on a clarification of concepts like "successive," "contiguous," "in contact," "intermediate" and of their mutual relations, he is taking up questions which had engaged Plato's attention in the Parmenides, where these concepts are invoked to throw light on the relation between the One and the others.(16) Aristotle's own discussion of them culminates, so to speak, in the introduction of an additional concept, the "continuous," which bridges the gap between the "contiguous" and the One, and which stands him in good stead when he shortly afterwards has to define what he means by "one movement" (in the sense of continuous movement). Yet its help extends much farther; for only because he has a firm grasp of the meaning of "continuous," "contiguous" and "in contact" can Aristotle attempt to prove the infinite divisibility of magnitudes, times, and movements, a thesis which, among other results, enables him to dispose of Zeno's paradoxes. The only instance in this whole set of problems where Aristotle admits indivisibility is the act of passing from rest to movement and from movement to rest. The "now" (or "instant") in which this happens has no extension at all in "time" and admits no subdivision. Here is a curious problem which stubbornly refuses to be treated along the same lines as the other changes. It, too, is a legacy from Plato. Once more it is the Parmenides which not only points out the peculiar nature and conditions of this event, but in effect anticipates some conclusions of the Physics: "There is no transition from a state of rest as long as a thing is still at rest, nor from motion so long as it still is in motion; but this queer thing, the instant, is situated between the motion and the rest. It occupies no time at all, and the transition of the moving thing to the state of rest, or of the stationary thing to being in motion takes place to and from the instant."(17)

Excursus. As I have mentioned Aristotle's refutation of Zeno's paradoxes, I may as well qualify what I have said about the relation of the Physics to Plato's thought by admitting that on occasions Aristotle reaches far back into the past

of physical thought and treats Presocratic doctrines as relevant to his purpose. Yet if we were to examine what use he makes of their doctrines (e.g., in his inquiry about the Infinite of in his discussion of the four causes) we would inevitably become entangled in very complex questions. How faithfully does Aristotle report the decisions of the Presocratics and how fair is he to their intentions? Almost invariably the doctrines are recast in terms and concepts that reflect a later stage in the development of philosophical thought. Instead of losing ourselves in these matters, which as you know have been thoroughly investigated by Professor Cherniss, let us rather give the Presocratics what credit they deserve for having begun, in however modest a way, to discuss the type of questions which Aristotle in the Physics discusses on a higher level and on a broader scale. What I have in mind is nothing less than the fundamental issues of physics. We see, in particular after Parmenides' great challenge, questions of this general type distill themselves from the matrix of more specific, i.e., cosmological, problems. When Empedocles, obviously at the beginning of his poem On Nature, sets forth the principles or forces whose existence he will assume throughout his account, when he states that they are exempt from genesis and that there is no genesis--and also defines what there is instead, namely mixing and breaking-up of mixtures--he is dealing with physical as distinct from cosmological and with general as distinct from special questions. There are reasons for thinking that Democritus said a good deal about the formation of compound bodies through their coalescence before he concentrated on the largest, most important, and most complex of all compounds, the Cosmos (or Cosmoi). Questions of this kind that are prior to cosmology increase in number, intricacy, and importance. Though we cannot trace this development through its various stages, we may--with all due caution, of course--form some impression of its extent by looking at Lucretius' poem. Here the basic physical questions are covered in the first two books, while the cosmology is treated in the fifth. As in so many other matters of content, approach, and arrangement of the material, Epicurus' system reflects in this point too the situation which had taken shape in the later period of Presocratic thought.

Does Plato's system reflect it likewise? It is hard to think of Plato as "reflecting" developments; also, as we already know, many new questions of this fundamental type originate with him and reflect, if anything, the specific pattern of his own system, the contrast between the realm of Rest and the realm of Movement, and the need for some relation between them. Movement itself, the

problems of *genesis*, and the four causes are among the subjects which Aristotle's *Physics* has directly inherited from this phase of Plato's thinking. Still, it is instructive to examine the contributions which the *Timaeus* makes to physics—once more physics as distinct from cosmology. For while the subject of this work is the Cosmos and whatever forms an essential part of it, one very important section, which is clearly designed to broaden the basis of Plato's account, leads us to conditions prior to the Cosmos and to questions that have precedence over cosmology. In the section which introduces the Receptacle Plato gives us his version of the fundamental principles which operate in every *genesis*, not only in the *genesis* of entities in the Cosmos. What he here does may well be paralleled with the information about the basic and unchanging principles of all generation which the later Presocratics vouchsafe—usually, I suppose, at the beginning of their treatises—e.g., with the information which Empedocles gives us about his eternal elements and their operation in forming and destroying all other bodies (I here ignore the fact that Plato speaks of true generation, whereas the later Presocratics had to introduce their readers to a substitute for it; actually here is one more parallel between this section of the *Timaeus* and the corresponding passages in the Presocratics, since Plato as well as his precursors explains what stand he takes on this crucial issue). The principles which Plato brings into play here are so conceived and their functions so described that they operate beyond the Cosmos. They operate throughout Nature. Whether any opportunity is left to them of operating outside our Cosmos is a question hardly relevant for our purpose. What matters more is that the conditions of all *genesis* which Plato here sets forth as prior to the Cosmos are prior in a twofold sense. They are said to prevail even before the Cosmos was formed; yet they are also more comprehensive and fundamental than anything whose bearing is confined to the Cosmos. This dual aspect of Plato's account may again be compared with what we find in the later Presocratic system; in them, too, principles are introduced which account for the formation of everything else (including the Cosmos), and a condition of things is shown which existed before the formation of the Cosmos.

To be sure, there is a large school of thought which would deny the temporal aspect of priority in Plato's account and, treating it as a mere *façon de parler*, would identify Plato's actual meaning with the other aspect. A good deal may be said in support of this opinion; yet from an historical point of view the alternative interpretation would seem to be preferable. At the very least, the Presocratic conception, including as it does temporal priority, provided Plato with a welcome opportunity of contrasting the well-ordered state

of things in the Cosmos with a very different condition, and also of treating genesis as unrelated to, and more basic than, the Cosmos. If we wish to understand the full significance of Aristotle's new departures, we shall do well to think of Plato as distinguishing between the cosmic condition of things and their natural, i.e., precosmic, condition. Plato has not made a complete break with the Presocratic scheme; the position of the Timaeus is half-way between the Presocratics and Aristotle.

Aristotle replaces the Platonic account of genesis which rests on the assumption of the Forms and the Receptacle by another which employs his own concepts of Matter, Form and Privation.[18] He does so in the Physics--a fact which adds justification to our attempt of differentiating also in his precursors between questions that belong to the realm of physics and others that may be called cosmological. What I mean by Aristotle's significant new departure will become clearer as soon as we turn to the second of our major topics and examine the basis of Aristotle's cosmology.

II.

The cardinal subject of Greek cosmology is the separation of the elements from one another and the division of the Cosmos between them. Among the Presocratics a large measure of consensus had been achieved. When the Cosmos came into existence, Earth and Water took up their place in the center, Air filled the spaces next to them, and Fire the outer regions of the world. However, these four elements need not find their cosmic home all at the same time. Fire or Air may break away first from the whirling masses and may move to its place, while the others are still struggling. Water is squeezed out by the Earth and presumably needs some time for gathering in the Sea. There are stages in the process of cosmogony. The Timaeus, however, knows no such stages. Plato's Demiurge creates the Cosmos in the only way befitting a divine Mind: thought and execution are simultaneous ("Swift as his word, his deed acts out what stands decreed," Aesch. Suppliants 598). What recalls the temporal sequence of the Presocratic schemes is so little, and this little so new and peculiar, that we may here leave it out of consideration.[19] And as it is below the dignity of God to need time for his work and alien to the nature of Plato's Cosmos that it should have come into existence by stages, so it is also unthinkable that in the origin of a work of such extraordinary perfection mechanical processes like the whirl would have played a part. In the formation of the Cosmos itself and of its more august

parts and regions the teleological cause reigns supreme and undisputed. If once the whirl and its far-reaching effects were needed to take the elements to their cosmic places, the Demiurge can now attain his ends without them. Yet as far as we can see, he has anyhow very little interest in distributing the available cosmic space among the elements. With great care and on the basis of very excellent thoughts he selects the four elements, establishes the best relationship among them, makes it a point to incorporate in the Cosmos all that there is of them and also to give each its proper mathematical shape; yet he has no thought to spare for their local arrangement in the Cosmos. Still, the traditional problem is by no means neglected. The movement by which the elements separate themselves from one another and tend in different directions is there; in fact, it is there even before the Cosmos. When the elements are produced in the Receptacle, they affect it, and it affects them, in such a way that motions are set up which take them to different places. Motions that have such effects might indeed create the Cosmos--but not for Plato. He denies the motions in the Receptacle this result, yet on the other hand makes them persist even after the formation of the Cosmos. In the Cosmos the motions still go on and still take the elements to their places.(20) In fact, this motif is the only definite and explicit link between what I have ventured to call the physical section of the Timaeus and its cosmological chapters--in the subject of genesis no comparable link is ever provided.

The divergent interpretations of the "physical" section make it difficult to assess the significance of this motif; for surely some significance must attach to the fact that the "cosmic" motions of the elements are not for Plato on a par with the numerous other features that spring from the Demiurge's carefully planning mind and set cosmic conditions apart from pre-cosmic ones. To infer at once that these motions must in a more fundamental sense belong to the nature, the physis, of the elements might seem a rash step, and in taking it we might seem to make unwarranted use of the term "physical section" which we have given to the account of the Receptacle, and which might itself still be in need of a better warrant than has so far been produced. Yet Plato after all calls the Forms the father, and the Receptacle the mother of whatever floating, unstable things appear in it. And if these entities--no longer quite so unsubstantial--owe their movement to their mother in a fashion which reflects the mother's own condition, it cannot be entirely fanciful to argue that these movements are a part of their nature. At least they are now more closely tied to

their nature--their heredity and birth--than was possible as long as external agents were needed to separate them and make them show differences of behavior. No such external agent is needed here. The mother who has at this very moment given birth to them is certainly closer to their "nature" than Strife or Mind or the conditions of a whirl could be. Moreover, this mother herself has a decidedly spatial character.

It is probably clear what I am driving at. The hypothesis on which Aristotle rests his entire cosmology is that the elements have "natural" movements and natural places in the Cosmos. For him, as for Plato, it is out of the question that any external influences or secondary developments should carry the elements to their cosmic regions. His own teachings depend in no way on the details embodied in the Timaeus; yet they reflect the new outlook in cosmology for which this dialogue is our first witness. For the rest, it goes without saying that Aristotle is much more explicit than Plato in regarding the movements to the appropriate cosmic places as inherent in the nature of the four elements. What he means by "nature" in this connection is not quite easy to determine. Although more than one definition might be extracted from the two latter books On the Heaven, we must perforce confine ourselves to one aspect.

Some elements move "upwards" and others "downwards" because the former are light, the latter heavy. They are so "by nature" and Aristotle as a matter of fact has in these books (III and IV) a way of speaking as though these qualities of weight and the corresponding movements constituted the nature of the respective elements and nothing else mattered--or at least as though nothing else mattered nearly as much. His doctrine of genesis, as expounded in other treatises, defines warm and cold, moist and dry, as the constitutive qualities of the elements. Yet in the cosmology of the books On the Heaven Aristotle pays no attention to these qualities but selects instead heavy and light, which he seems to regard as equally "constitutive." From a historical point of view the two doctrines represent steps in the same direction; in both instances we may think of Aristotle as reversing a trend of thought which had lately gained strength. For the atomists had demoted many of the old "powers" to the status of sensations --sensations of the percipient that are caused by the shape of the atoms, yet are no part of their nature. The Timaeus too treats hot and cold and also heavy and light in the section assigned to the phenomena of sensations and as far possible as sensations (I have qualified this statement because the Timaeus also shows that not a few of the traditional powers resist their demotion to

the lower status of sensations).[21] As regards heavy and light in particular, Plato, while considering them as sensations, has yet to make concessions to other points of view. He admits--for a moment at least--that a discussion of them must be mindful of "up" and "down" in the Cosmos, and he fully recognizes the necessity of taking the cosmic places of the elements into account. The essence of his definition is that the sensations of heavy and light are due to the tendency of the elements towards their proper places and that a large amount of an element will have this tendency more strongly and therefore appear heavy by comparison with a smaller amount, which seems light. This is different enough from Aristotle's doctrine, according to which some elements are by nature heavy and others by nature light; yet in the course of his discussion Plato formulates an important distinction which recurs in Aristotle: an element is either in its natural place or in a place which is contrary to its nature, and in the latter case is there "by force" (biai). This is the only passage of the Timaeus where Plato speaks of "force" as the opposite of "nature"; on the other hand, Aristotle's doctrine of "natural movements" owes its whole point to the contrasts between movements by force and movements in which an element follows its own "nature" or natural bent.[22]

Aristotle did not need to redefine the concept of force yet he had to redefine "nature", at least to the extent of purging it of all remnants of the old notion--still alive in Plato--that elements seek their natural places because like congregates with like (though in one passage he accepts this notion with the proviso that "like" too be given a new sense).[23] He also had to redefine the meaning of "up" and "down" in the Cosmos and in doing so restores to these concepts the traditional and popular meaning--perhaps also the "Presocratic" meaning--which Plato had expressis verbis repudiated.[24] Finally he had to provide a new definition of heavy and light.[25] This definition makes no reference to human sensation. Heavy and light belong to the nature, in fact they are the nature of the elements. These are large and fundamental changes, yet we falsify our perspective if we compare the doctrine of the books On the Heaven with one particular section of the Timaeus (the notion that individual passages of this work formed the starting point for Aristotle's physical thinking is in any case a bad principle). In other sections of this dialogue Plato does not hesitate to refer to a physical body as heavy or light, and not at all in the sense that it is heavy or light, and not at all in the sense that it is heavy or light when out of its proper place. The most important of these passages occurs remarkably

enough in his account of the Receptacle where the elements that move in it are not indeed said to be light or heavy but are compared to objects in a winnowing basket, some of which are light and others heavy.[26] This is the section in which we found Plato dealing with the "nature" of the elements--their pre-cosmic nature, and it would seem that light and heavy here come very near indeed to the point of entering into the "nature" of the elements.

Aristotle made the final step. Yet as soon as elements are regarded as "by nature" heavy and light and their movement towards different cosmic places is ascribed to these qualities, the distinction between their natural, pre-cosmic condition and their cosmic status--the distinction which still had a certain appeal to Plato--collapses.[27] Aristotle realizes this very clearly and draws the conclusions suggested by this new situation. If it is "natural" for fire and air to be in the outer cosmic regions because they are light, and natural for earth and water to gather in the center because they are heavy, it follows that they must always be and always have been in these places. The notions on which the Presocratics have proceeded are exactly the reverse of the truth. For elements it is not "natural" to be in other than their cosmic places and conditions but "contrary to nature" (this after all Plato too says in his account of heavy and light). Force (say, a whirl) is not needed to bring the elements to the places which they now have, but force would have to be at work if they were ever to be in a different condition. Cosmology must entirely abandon the time-honored assumption that the basic physical entities which eventually were to form the world were originally in a different state or place and that only under certain specified conditions and through the agency of certain particular forces could the world evolve into its present state. In other words, cosmology can no longer be cosmogony. Also, of the two aspects of traditional physical thought which are still combined in Plato's section on the Receptacle, that of temporal priority is now definitely out of date. The one and only function which Physics as distinct from Cosmology still has is to deal with questions of more general import, with subjects like Movement, genesis, causes, space (but the locus of all of them is our Cosmos). It may however be argued that Physics in addition to this, as we have seen, traditional task, acquires a new task and a new subject, since if the Cosmos is not altogether self-sufficient but depends on a first principle of Movement outside itself, it is Physics which will have to take care of this first entity.

In the third book of the treatise On the Heaven in which Aristotle establishes the concepts of "natural movements" and "natural places" he hardly

avails himself of them to argue that the Cosmos must be eternal or that our Cosmos is the only (i.e., only possible) Cosmos. In the first book, on the other hand, the latter thesis is proved by more than one argument that employs these new concepts; yet the eternity of the Cosmos, while discussed at length, is not even here made to rest on them.(28) It would certainly be a serious mistake to ignore the reasons and motives of an entirely different complexion, in particular the religious motives, that have shaped the new belief in the eternity and divinity of the Cosmos. The argument from "natural places" is in harmony with this belief and capable of supporting it on the cosmological or physical side.

Whether Aristotle felt triumphant when he brought scientific cosmology into line with the new outlook is beyond our means to determine, but he certainly was in a very triumphant mood when this new approach produced one further piece of doctrine which was so important and so revolutionary in its implications that it dwarfed everything else that he had achieved with the help of his new "hypothesis." If the movements up and down are inherent in the "nature" of particular elements, the same must be true of the circular movement. This reasoning leads to the introduction of the "fifth body" (more commonly called the aether). Yet as the circular movement differs from the others in that it has no "contrary," it must be eternal and so must be the element which performs it. While the other four elements change into one another, this one is not subject to change and is exempt from genesis. It is in fact eternal and divine and in speaking of it Aristotle is no longer reluctant to cross the boundary that separates cosmology from theology and religion.(29) It is in the shape of this element that divinity and eternity are present in the Cosmos--yes, indeed, Aristotle's Cosmos "incorporates" Eternity while Plato's only incorporated Time.(30) Moreover, the new element, by being responsible for the circular movements of the Heaven and all other circular movements in the outer regions of the Cosmos, takes over essential functions of the Platonic world-soul. Although Aristotle's polemic against this Platonic conception is relatively slight, he is clearly aware of the great methodical superiority of his scheme in which one and the same principle--the hypothesis of natural movements--explains the heavenly movements and the movements in the sublunary region. He has unified these two phases of cosmology and has done so without sacrificing the far superior status of the heavenly regions. Moreover, the basic hypothesis which has made possible these achievements has in his eyes the great advantage of being a genuine "physical" hypothesis. This means that it involves no trespassing into the realm of mathematics. For Aristotle mathematics and the realm of nature are two different

worlds; quite apart from the specific flaws which he discovers in Plato's mathematical construction of the elements, the very fact that Plato used mathematics to account for physical data is in his eyes an unpardonable methodical error.(31) The historian of science will be inclined to take the opposite view and regard Aristotle's elemination of methematics from the study of the Cosmos as a "fatal" or retrograde step. Obviously the far-reaching results which Aristotle harvested with the help of his purely "physical" hypothesis confirmed him in his inclination to "departmentalize" science. The method adopted in the book On the Heaven is of a piece with the methodological axioms laid down in the Posterior Analytics which insists that each subject be established on its own first principles and basic "hypotheses."

The doctrine of the "fifth body" is so unquestionably the most important result of Aristotle's novel approach that one is led to wonder whether it did not actually inspire this approach and whether the treatment of the four other elements along the same lines may not be secondary in origin (as well as in importance). Is it possible that the doctrine of natural places and movements as applied to the four sublunary elements is an extension (made ex post) of a theory which, in connection with the ether, had yielded such extraordinarily rich fruits? Actually, in the books On the Heaven the discussion of the other elements comes second--though not necessarily as a "poor second"--to the eloquent chapters which deal with the circular body and its circular motion. A case might well be made out for this view of the origin and subsequent elaboration of Aristotle's cosmological doctrines. There are no inexorable facts, no incontrovertible items of evidence--textual or otherwise--with which this view would conflict, and it has the advantage--whether great or slight is another question--of accepting the doctrines embodied in the books On the Heaven in the sequence in which they are presented. On the other hand, the two latter books of this work, which deal with the traditional elements, do not in any way presuppose the two former, which incorporate the doctrine of the fifth body. The doctrine is never alluded to in Books III and IV--on the contrary, it is ignored and sometimes(32) it is hard to see why Aristotle ignores it so completely and to acquiesce in the notion that he (deliberately?) adopts a manner of speaking as though he had never heard of the fifth body and the third cosmic movement. Surely there is much to be said for the view that Aristotle at first developed the doctrine of natural movements and natural places in connection with the four traditional elements, and that he only later discovered the possibility of extending it to

a new one. And if this opinion is as little capable of cogent philological proof as the alternative, we should yet not forget how much there is in the Timaeus--and how much there may have been in the discussion of the Academy--that pointed in the direction in which we see Aristotle proceeding. If the Timaeus approximates the idea of natural movements and knows of natural places occupied by the four elements, it is after all more likely that Aristotle began by developing the possibilities here indicated of establishing cosmology on strictly physical foundations. Here was his chance of putting something better in the place of Plato's mathematical account of the elements. I find no difficulty in believing that this project had taken shape in his mind, and perhaps even on paper, before he realized that the new hypothesis--duly modified--also provided a principle of explanation for the more august phenomena of the Cosmos of which the Platonic world-soul had so far taken care.

III.

In speaking of Aristotle's physical hypothesis as designed to replace Plato's mathematical construction, we may seem to make an unwarranted assumption. For Plato's mathematical approach to the elements is not intended to account for their movements but is meant to explain their genesis and their subsequent behavior. Is it not evident that a theory which considers the elements from the point of view of their movements--and comes near to identifying their "nature" with the capacity to perform such and such movements--cannot at the same time provide a clue for their genesis? As we have seen, the only qualities that Aristotle in the two latter books On the Heaven assigns to the four elements are heavy and light--qualities which are admirably suited to the explanation of cosmic movements yet utterly useless when the origin of the elements and their mutual transformations are to be cleared up. As a matter of fact, Aristotle himself is perfectly aware of these fatal limitations that attach to "heavy" and "light"; in the treatise On Coming to Be and Passing Away he dismisses them on the ground that they have no "active" or "passive" characteristics and decides to operate with other qualities which can act upon and suffer from one another.(33) Yet, curiously enough, in Books III and IV of On the Heaven he seems to make a perfectly serious attempt to understand not only the movements of the elements but also their genesis--and to understand it without endowing them with any new qualities or characteristics.(34) To be sure, he does not get very far, and his results are largely negative; when he has refuted

earlier theories of genesis and in particular Plato's mathematical version of it (to which he comes back again and again), he has to content himself with the conclusion that the only possible way in which elements can come into being is to originate out of one another. This conclusion is far from new; it merely reaffirms the conviction which had already guided Plato in the Timaeus. Yet if Plato had shown in detail how these mutual transformations come to pass, Aristotle, committed as he is to his specific premises and hypotheses, finds himself unable to do the same. The details of the process elude him and the basic problem remains unsolved (at the crucial point, i.e., at the end of Book III, Aristotle decides that before he can proceed farther he must investigate the basic properties in which the elements differ from one another; this he does in Book IV; yet once more the only basic differences of which he takes account are heavy and light, and he never finds his way back from this subsidiary investigation to the larger subject of genesis).

It is difficult to resist the impression that the new theory of the elements has somewhat over-ambitiously tried to cover matters for which it is not equipped. How correct this impression is--and how much we are to make of it--is another question. While these two books are in all probability earlier than the treatise On Coming to Be and while it is not possible to regard them as working up to this treatise, we are still not bound to assume that Aristotle at the time when he wrote these books knew of no other way of approaching the genesis of the elements. Should he really not have known that the elements, besides differing from each other with respect to weight and lightness, are also either hot or cold, either moist or dry? These are the qualities of which a satisfactory theory of genesis must make use; they alone can explain how Matter may assume the form of an element, and they alone can, thanks to their interactions, make it possible for one element to change into another. For they are indeed "active" and "passive" and stand to one another in the relation of acting and suffering. To be sure, if they are to perform such essential functions they must have a status considerably higher and more objective than that of sensations. Although Aristotle in the chapter of Coming to Be in which he selects these four qualities refers to them as differences with regard to sensation--(35) more precisely, as "differences with regard to (the sensation of) touch"--he actually thinks of them as essential and constitutive qualities of the elements. As we have seen, heavy and light had to undergo a corresponding change of status before they could serve as foundations for the doctrine of cosmic movements. The

parallel development in both fields is noteworthy, even though as far as I can see Aristotle nowhere actually makes it a point to argue for a new status of any of these qualities. As a matter of fact, Aristotle's cosmology and his theory of genesis rest on similar foundations inasmuch as both use qualitative "differences" that are considered as constitutive properties of the elements. Yet similar foundations are not the same as identical foundations. Identical foundations would be desirable but are unfortunately out of reach. Aristotle's attempt to establish both subjects on identical foundations and to apply the same hypotheses which had proved so useful in cosmology also to the solution of the genesis problem has led him into a blind alley. Bifurcation was the inevitable price which he had to pay for his desire to give the movements of the elements a more central place in the cosmological scheme than the Timaeus allowed for them. Looking at this bifurcation from a larger historical perspective one may consider it as an alternative to the special devices--the whirl or the activity of Mind or Strife--which the Presocratics had employed to make their basic physical entities arrange themselves in the form of the Cosmos.

We have earlier in this study referred to the section of the Timaeus in which genesis is rehabilitated.(36) The genesis which Plato here has particularly in mind is that of the elements. For a number of reasons are too complex to be here set forth in detail. Suffice it to say that if the existence of the elements is taken for granted all other physical objects may be explained as arising from a coalescence of these elements--which is not necessarily a true genesis--and that we find Plato himself availing himself readily and extensively of this possibility.(37) Another point to be borne in mind is that while Plato accepts Empedocles' four elements as the basis of his physics, he heartily disagrees with Empedocles' attempt to treat these elements as eternal and unchanging principles. On this cardinal issue Plato in effect takes his stand by the side of Anaxagoras and Democritus, who allow change from one element into another--yet for them the elements had not been the first principles of nature.

The section on the Receptacle includes some references to the constant changing of the elements into one another but the brief statements of the kind do not anticipate or adumbrate any of Aristotle's peculiar solutions. After all, change from one element to another here takes the form that one element arises instead of another--thanks to the continuous productivity of Being --yet the elements are not shown as arising out of one another. Still, the description of the Receptacle itself as devoid of all form, deprived of all particular and

specific characteristics and therefore capable of receiving them and losing them again springs from the same root conception which also inspired Aristotle's creation of the concept of Matter. It would surely be a mistake to minimize the difference between these two concepts; and yet it seems clear that consensus had been reached in the Academy--or at the very least agreement between two of its members--on this all-important point: the substratum of all genesis must be utterly shapeless and have no distinguishing characteristics of its own.

Yet Plato does show how the elements change into one another. We must again shift our attention to another part of the Timaeus. In the Cosmos--as distinct from the "precosmic" conditions of "Nature"--the elements have constitutive parts which can regroup from the particle of one element into that of another. At least the particles of three elements can--for some reason, Plato has seen fit to keep Earth out of this constant process of transformation. To be sure, the mathematically conceived basic particles of the elements are in no way comparable to Aristotle's Matter; they link the elements to entities of higher ontological standing[38] whereas Aristotle constructs his theory of genesis "from the bottom up." In what regard then is this Platonic account of the transformations undergone by the elements in their cosmic phase comparable to Aristotle's treatment of genesis in On Coming to Be and Passing Away? Both accounts explain simultaneously a) how the nature--or structure--of the elements makes it possible for them to change into one another, and b) how the elements act upon one another.[39] In Plato the solid bodies (cubes, pyramids and so forth) that constitute the particles of one element are broken up by the action of solid bodies forming another element. This means that the elements are active and passive in relation to one another. They would satisfy the criterion by which Aristotle selects the qualities which in his scheme build up the elements and account for their mutual changes. In fact, it is in this section that Plato formulates a principle destined to become fundamental for the theory of interaction: nothing can either suffer from, or effect a change in anything that is generically identical with it.[40]

This section of the Timaeus may easily be the first attempt to establish an intimate and deliberate connection between the subjects of mutual change and mutual interaction. To be sure, if Anaximander made the hot of the Sun or of the outer cosmic regions dry up a good part of the sea, he combined in one and the same development an action of the hot upon the moist and a change from moist to dry. Similar coincidences may be found in other phases of his system and in

other Presocratic systems. Still, it may be doubted whether any of the earlier physicists was able to describe in generalized fashion how elementary interactions produce elementary changes.

Moreover, Plato may well have been the first who introduced the terms "acting"(poiein) and "suffering"(paschein) as a pair of complementary concepts into physical and philosophical thinking--so far, at least, no instance to the contrary has been found in the fragmentary remnants from earlier periods. These concepts seem to have satisfied his desire for stating what he had to state in the most general and most comprehensive terms. The Theaetetus identifies "acting" and "suffering" and two forms of Movement; yet they are not forms of Movement in the same sense in which alteration and locomotion are so defined. Rather, they are what we should call two aspects of one and the same movement (or change). The axiom quoted from the Timaeus and a number of other passages in Plato's later dialogues bears witness to the importance which this pair of concepts acquired in his thought.(41)

How natural is it for elements to act upon one another? Without suggesting that it is inconsistent with their nature (as conceived in Presocratic thought), one may yet feel that it is more in the nature of the "powers" (like hot and cold, dry and moist, bitter and sweet) to inflict suffering and make whatever comes their way feel their "power." In Plato's scheme the elements are capable of acting upon one another because their particles have mathematical shapes and are provided with sharp edges and pointed angles. They can bruise, cut and destroy, and when they meet one another they drive home their attacks in a spirit remarkably out of keeping with the condition of amity which the Demiurge had been so anxious to create between them. Not Friendship, but bitter Presocratic warfare--War, the Father of all things--is the ruler of their world and makes water change into air and fire be quenched by water.

In Aristotle's corresponding description of elementary changes the imagery of warfare has become a good deal paler, yet it still is the case that the antagonistic forces overcome, and are overcome by, one another. Moreover, as the battle--if we may still speak of battle--is now joined not by the elements as such but once more by their respective powers, the opposing parties are antagonistic in another and better sense than they were in Plato. They really are "opposites." It is easier for hot and cold, or moist and dry--or for any other complementary pair of powers--to be opposites than it is for water and earth or even for water and fire. Plato had not been able to avail himself of

this natural opposition. He found it necessary to transfer the "power" of acting and suffering from the powers to the elements (the temptation of supposing that in his scene of cosmic struggle and cosmic changes between the elements the powers must after all be latently at work should be resisted, pace Cornford).(42) Aristotle, on the other hand, has along with the mathematical configuration of the elements surrendered the possibility of making the elements as such act upon each other. What acts and what actually changes in his scheme is once more the powers--even though they are no longer meant to be powers in the Presocratic (or Hippocratic) sense of the word. They should be no more than qualities, qualities that inform matter and when properly combined give matter the form of an element (matter qualified by hot and dry is fire, by hot and moist is air, etc.). Yet the powers are used to something better; they have not forgotten their former status. Aristotle has a hard time keeping them in check, i.e., keeping them reduced to the status of mere qualities. After all, has he not himself declared that it is in the qualities that the capacity to act and suffer resides, and has he not with this consideration in mind made his choice between the various available qualities?(43) No wonder, then, that they tend to get out of hand,--the replacing of one quality by another--the only way in which the elements may change--cannot come to pass quite peacefully; there must be some conquering, "overcoming," and "destroying." Obviously the logic of his own construction made it necessary for Aristotle to grant these "qualities" more independent activity than the definition of quality would seem to permit; yet the demands of logic somehow coincide with those of tradition. Nor should we, when seeing the qualities achieve a kind of semi-independence in the treatise On Coming to be, forget that in biological works like On the parts of animals they enjoy complete independence. The hot, in particular, is in these works as real and as powerful--active and alive, creative and consolidating--as it has ever been in earlier medical and physical thought.

In Plato's account elements change because they act upon one another. The two subjects which are theoretically distinct and historically to a certain extent distinguishable, are treated jointly and have almost become one. In Aristotle's corresponding section we find the same interlocking, even though, on the whole, more emphasis is given to change than to interaction and thugh Aristotle at the beginning of the chapter announces it as his intention to deal with the changes. Yet it is clear beyond doubt that if, e.g., the moist replaces the dry--causing a change from fire to air--it does so because it has overcome

the dry, and Aristotle has after all chosen the best available qualities with "active" and "passive" characteristics because the elements "mix and change into one another."(44) That the elements act on one another is on the whole obvious enough from the details of his description, even if the conditions under which they do so remain somewhat obscure. In clarity and concreteness Plato's account seems to have the edge on Aristotle's, yet it is only fair to remember Aristotle's purpose. In accordance with the plan of this work, he deals with all possible changes in the most general fashion, paying no attention either to cosmic places or to specific situations which in our Cosmos may bring about an interplay between the elements (only after Aristotle has covered all changes in this extremely generalized fashion does he allow himself to apply his theory to conditions prevailing in our Cosmos; after this point his expose becomes in fact remarkably more specific).(45) Given the restrictions that Aristotle has imposed upon himself for the bulk of the treatise, a certain abstractness was obviously unavoidable.

If the qualities bear the brunt of the battle while the elements reap, as it were, the results, these "active" and "passive" powers must have taken over some of the functions which Plato had delegated to the mathematically constructed particles of the elements. What then is the gain, or what would for Aristotle himself be the gain inherent in the novel approach? That he is in principle opposed to a mathematical basis of Physics and determined to find an alternative we already know and it will not be necessary to labor this point again. For the gain must be stated in much more concrete terms. While Plato's triangles and solid geometrical bodies have, if any, only an indirect and tenuous connection with the Receptacle, Aristotle's qualities are the primary qualifications of the substratum and operate on it directly. Thus they secure (in principle at least) a very firm connection between the physical elements and the substratum--that they often forget their place between the substratum and the elements is another matter. Moreover, Aristotle finds himself in a position to make a complete break with the corpuscular theory of material composition and indeed with any theory which tries to build up a physical body as an aggregate or particulars, whether they be atoms, geometrical entities, powers conceived as "being things," or minimal elementary units homogenous with the larger conglomerations of elements. All major systems that had taken shape after Parmenides had approached the origin of physical object along such lines. All were guilty of the same fundamental mistake. "It is wrong to suppose as some do that coming-to be and passing-away in the simple and perfect sense are defined by "association" and "dissociation"; on the contrary this is where the whole error lies."(46)

A physical entity has its substratum and its form which gives it its organic unity; it is wrong to treat it as the result of a mechanical aggregation of minimal bodies. If an element comes into being, i.e., if one element changes into another, the change must come to pass in its constitutive and qualitative determinants; it cannot happen through the breaking away of quantities of such and such material and the joining up of qualities of another material. Aristotle's main effort in the chapter from which we have quoted concentrates on the problem of indivisible quantities. There are arguments for and against positing them, he is willing to admit--until he finally states the decisive reasons against it--yet this is not the main issue in the doctrine of genesis (the energy and the number of arguments that he has devoted to this problem may nevertheless obscure the significance of the much briefer statement which revolutionizes the entire outlook in the subject). What matters in the end is not whether a body can break up into a finite or infinite number of quantitative parts but whether breaking up and putting together is the way in which genesis operates. And as we already know, Aristotle's answer to this question is emphatically negative.

In justice to the later Presocratics it should of course be remembered that their aim was not to explain genesis but rather to show how the arising and and disappearing of physical entities could be understood without the help of this concept. The alternatives which they had put in the place of coming-to-be and passing-away are association and dissociation, i.e., the concepts which Aristotle not quite fairly condemns as inadequate and superficial "definitions" of coming-to-be and passing-away. Yet, even after genesis had been brought back into honor, association and dissociation continued to cast large shadows over the field which they so long had occupied without a rival claimant. In the description which the Timaeus gives us of the cosmic struggle between the elements we see these come into being by the breaking up of geometrical figures into their component triangles and by the regrouping, i.e., by a new association of the same triangles in the pattern of another geometrical figure.(47) The triangles composing a pyramid are by force separated from one another--to say nothing of the separation of pyramid from pyramid and of one group of pyramids from another. Moreover, compound bodies, springing from a mixture of the elements could not come into existence if the elements were not ready to enter into, and dissolve, associations with one another. There is in these chapters no hint of a more "organic" conception of physical bodies. To be sure, Plato's introduction of mathematical entities has shifted the entire discussion to a different plane.

The triangles do not "compose" a pyramid in the same sense in which atoms or powers may build up any given amount of an element. Let us make all due allowance for this new approach to "composition"; it still remains true that Plato operates with the concepts and somehow moves within the pattern created by the later Presocratics.

Moreover, what we find in this section of the Timaeus is confirmed by other passages of the late dialogues where Plato uses the terms association and dissociation unblushingly and seems to regard them as essential for the understanding of major physical changes. One of these passages is again the comprehensive catalogue of all movements in Book X of the Laws.(48) Here Plato hands over to association and dissociation the control of growth and decline, two basic changes, for which incidentally Aristotle would admit the quantitative-mechanical explanation as little as for genesis itself. Here even passing-away is at least partly left in their power. However, when at the end of the list genesis is mentioned, Plato sees fit to make a rather abrupt change of approach by which he keeps genesis outside the range of these two concepts. There are indeed hints--but hardly more than hints--to the effect that the breaking up and re-combining of parts is not Plato's last word on the subject of genesis: the account of the Receptacle includes some passages which might lead us to suppose that what primarily and directly affects the Receptacle is the "powers"--just as in Aristotle it is the qualities which directly and primarily qualify Matter.(49) However, what these passages offer is as floating and unsubstantial as anything that is to be found in the Receptacle. On the other hand, it is not certain that we are right in regarding Plato's account of the mutual transformations of the elements in the Cosmos as an authentic answer--one out of three; for in the Timaeus Plato has a "physical" approach to genesis (in the sense in which we have called the section on the Receptacle "physics); he has an ontological-mathematical, which is however primarily meant to provide the elements with a philosophically respectable pedigree and suggests nothing concerning the physical conditions under which they come into being; and finally there is the section dealing with their cosmic changes and cosmic coming into being, which, whether or not representative of Plato's thoughts about genesis, certainly embodies conceptions and motifs that have their analogues in Aristotle's corresponding doctrines.

From the genesis of the elements Aristotle goes on to that of mixed substances. Among these the so-called homoeomere or homogeneous substances had for some time attracted particular attention and had--with Empedocles and Anasagoras in any case(50)--become a philosophical problem of the first order of

importance. Aristotle evidently takes it for granted that as soon as the elements and their genesis have been satisfactorily explained, his inquiry should move on to the homoeomere; in concentrating on them and even more in choosing the tissues as representatives of this class he is keeping close to the Presocratic tradition.(51) It is hardly astonishing that he ignores some principles of explanation by which Plato in the Timaeus accounts for the nature of a large number of homogeneous physical entities (like the metals and juices); for these explanations presuppose the composition of the elements out of mathematically determined particles. In his opinion Plato ought to have, along with the element cleared up the nature of the tissues. Actually Plato does explain their composition in a later section of the Timaeus, and in doing so he avails himself of the same traditional concept which dominates also Aristotle's discussion of the subject (and which, as a matter of fact, Plato also employs in his account of metals, juices, etc.),(52) to wit, the concept of mixture.

It is hardly necessary to review the history of this concept. For Empedocles, all physical substances that are not elements are mixtures of them, and the tissues are particularly interesting and distinguished--we may say, perfect--mixtures. Yet when his successors refused to follow him in regarding the elements as basic and unchanging principles, the elements too became mixtures. For Anaxagoras, the "powers" by their mixture build up water and air no less than bone and flesh, and Democritus' atoms are not likely to have fallen behind in this respect (we may here ignore the one exception which is or seems to be attested, namely, his identification of the spherical atom as fire atom). In fact, it is well to note that the two concepts which Empedocles and Anaxagoras put in the place of the tabooed notions of coming-to-be and passing-away are not association and dissociation, but mixture and dissociation.(53) This may well raise the question which term and principle Empedocles used for the aggregation of larger masses of, say, fire or earth; yet there is no need here for going into this question which may never have presented itself to him in this form. In any case, it is easy to see why for his immediate successors the two processes of association and mixture tend to coincide. Yet when, with Plato and Aristotle, Empedocles' four elements were once more elevated to basic principles, a greater need was felt of distinguishing between association and mixture. In Plato no mixture--at least no mixture of the usual type--takes place when the particles that form one element come together in large masses; all that happens in this case is association.(54) On the other hand, the formation of composite yet

homogeneous substances requires mixture as well as association of his mathematical bodies (though, in effect, it may be noted, Plato seems to feel that the close texture of the tissues cannot be adequately explained by a process of mere mechanical association)[55]. Thus the concept of association to which Aristotle is so utterly opposed was firmly entrenched throughout the doctrine of origins. Whether genesis was admitted or rejected, association was the process by which elements as well as composite bodies came into existence and dissociation the process by which they passed out of it. Mixture, on the other hand, had once more become confined to composite bodies.

We have already dealt with the new theory by which Aristotle explained the genesis of the elements without using the concept of association. We have also seen what new relationship he establishes between the elements and the erstwhile "powers," now conceived as qualities. What is changed--or exchanged--when the elements pass into one another, is in the first place these qualities. We may now add that also in his doctrine of mixture the qualities are the actual agents and combatants. The elements evidently could not mix if the powers did not perform this process on their behalf. Warm and cold, moist and dry can mix, the result being an intermediate condition anywhere on the scale between the extremes[56]. To be sure, if the opposite powers meet in equal strength--literally, with equal power--they will cancel each other, in which case, as Aristotle very clearly realizes, the outcome of their meeting and mixing would not be the formation of a tissue but simply the sinking back of the elements into the unqualified substratum (if neither hot nor cold is present the conditions for the existence of an element are gone). Fortunately, however, this happens only on one point of the scale; exactly half-way between the extremes of hot and cold is the zero point, and when both qualities are present in an extreme degree (or an equal degree) they must indeed both be reduced to zero. If, however, of the two elements which mix, one is hot in a higher degree than the other is cold, the resulting tissue will still be hot, yet less hot than the element which threw its hot quality into the mixture. It all boils down to the question, how hot or cold the elements are.

Yet what we should call a question of degree is for Aristotle, as he here frankly admits, a question of "power". For along with the "active" and "passive" capacities of these qualities their character as "powers" is once again very conspicuous. True, in some passages a good deal of care is needed to decide whether Aristotle uses the term "power" in the traditional sense of the concept

or in his own new meaning of "potentiality", yet the "power" concept is there (and has been recognized by the late Professor Joachim). Even of the mixed body Aristotle says that its hot power--presumably its power of heating--is twice or three times as great as its cold power.

If elements had to change "as a whole" when passing into one another, they must do the same when they combine to form a kixture. Otherwise no "new" body or new substance would come into being. We may speak of a "qualitative" change in this substance, and have the more right to do so as Aristotle himself traces the change in the qualities. Yet this kind of change must be clearly distinguished from the qualitative change which figures among Aristotle's four basic classes of movement and which he is always anxious to set apart from genesis.

Here, too, Aristotle combats the idea that anything can be gained by thinking of a natural body as consisting of distinct minimal quanta, lying side by side and forming the "mixed" body simply by virtue of their aggregation. (57) This would mean that in a mixture the particles of one substance would in regular sequence lie next to those of another; yet however complete this intermixing, the original substances would be preserved in the resulting body and nothing really new would come into existence. A body in which qualitatively different parts could be distinguished (even if perhaps not by human eyes) would not be a truly homogeneous body and could not be considered as an organic entity.

The concept of mixture had been introduced at a time when genesis had no place in serious thought about physical processes. It was designed to take the vacant place. Yet even after genesis has made its come-back, mixture continues to be regarded as a valid concept. While Plato (who brought genesis back) is tolerant towards mixture as well as towards association, Aristotle spurns the latter concept yet is ready to come to terms with the former. In fact, he needs it badly to make the transition from elements to compound entities, and if he regards the tissues as mixtures, this means in effect that his entire theory of secondary compositions (homoeomere) and indirectly also that of tertiary compositions (anhomoeomere) rest on the concept of mixture. Yet in order to perform so crucial a function the concept had to be cleared of what it brought along from the period when physical entities arose through mechanical coalescence. There is a certain historical logic in Aristotle's effort to raise mixture to the level of true genesis. He is undoing what had been done while genesis was non-existent and association had established itself in its place.

NOTES

10. Soph. 249d.

11. X, 893b ff.

12. 57d; cf. Cornford, Plato's Cosmology, 245.

13. 52d ff.

14. Phys. VII 7, esp. 260b15 ff; for inclusion (or not) of genesis in the genus of Movement see W. D. Ross, Aristotle's Physics 7 ff.

15. 11, 10 ff.

16. Phys. V, 3 (cf. VI, 1 and 2); cf. Pl. Parm. 148d ff.

17. Parm. 156d (Cornford's translation has been used); Ar. Phys. VI, 3. Note that Plato is not concerned with divisibility.

18. I, 7 f.

19. Tim. 34b/c ff.

20. 52c ff., 57c; see also 58b/c.

21. Tim. 62c-63e.

22. Tim. 63d (end); however, the notion of "force" and "forcing" is present throughout the section, Arist. 300a20 and passim.

23. VI, 3; 310a31 ff.

24. 308a14; Tim. 62c.

25. Iv, 3.

26. 52e/53a (see also 58e2, 59c1, 60c3).

27. On the Heaven III, 2, 300b8 ff.

28. I, 8 f.; 10 ff.

29. I, 2 f.; 9 (end) and II, 1.

30. Arist. 279a25; Tim. 37d ff., 38b ff.

31. See esp. 306a5 ff.: hypotheses should be "homogeneous" to the subject.

32. The opening sentences of Book III (298a24-b11) are immaterial. They constitute the only link between the two sets of books, yet they merely prove that Aristotle at one time wished to combine his treatise in larger units.

33. On Coming to be II, 2; 329b20.

34. 298b8 ff.; ch. s 111, 3 ff.

35. II, 2; 329b7 ff.

36. 48e-53c.

37. Tim. 57c f. 58c-61c.

38. Tim. 53c ff., esp. d6.

39. Tim. 56c-57c (58a-c), On Coming to be II, 4.

40. 57a.

41. Theaet. 156a (cf. 159a, d, Soph. 247d, Parm. 138b, Phaedr. 270b ff.).

Notes II

42. Plato's Cosmology, p. 229

43. II, 2; 329b20 ff.

44. Ibid.

45. On Coming to be II, 8 ff.

46. Ibid I, 2; 317a17 ff.

47. 56c ff.

48. Legg. X, 893b ff.

49. 50a2 f., 52e1 ff. (51a6?).

50. Emp. A 78, B 96, 98 (see also B 71, 73), Anaxag. A 45, B 10 (Diels-Kranz).

51. On Coming to be II, 7; see also I, 10.

52. Tim, 73b ff (tissues), 58d ff. (metals, etc., 59e ff juices); Aristotle's criticism: A 2, 315 a 29 ff.

53. See Note 7.

54. See e.g., 56c; however, if particles of an element exist in different sizes, these sizes may mix (57c f., 58c ff., 59e)--a complicating factor to which I am not paying attention.

55. Hence not only the teleological point of view but also the motif of special precautions lest the mixture again dissolve. Cf. Emp. B 73.

56. On Coming to be II, 7; 334b2 f.

57 ibid., I, 10; 327b31 ff.