
(伊比鸠鲁哲学之"最小部份": 论其起源，性质以及功能)

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伊比鸠鲁哲学之“最小部份”：
论其起源，性质以及功能

本文係討論“最小部份” (minimae partes) 在伊比鸠鲁哲学裡的重要性，及其廣泛的意涵。採取之方式乃将此概念，置於伊比鸠鲁之前的希臘哲學傳統以及伊比鳴魯派哲學系統本身之中，來看待處理。為了這緣故，必須把伊比鳴魯之前以及之後的相關理念來一起討論，重新建構此概念之演變發展；亦即對“最小部份”做一次意念史 (history of idea) 的探討 (Part I)。討論的哲學家包括 Zeno of Elea，前蘇格拉底哲學中的原子論，柏拉圖學院之 Xenocrates，以及可能屬於辯證學派之 Diodorus Cronus 等，最後則討論伊比鳴魯派哲學。這種尋求“最小部份”在歷史裡的演變，將讓我們理解到它與希臘自然哲學中一些基本概念，例如，時間、空間、運動、靜止、體積、連續、斷歴、無限等等，皆有關係 (Part II.1-II.5)。

本文欲證明，伊比鳴魯學派相信在前蘇格拉底哲學中，物理上不可再行分割的原子，其實可在概念上以及邏輯上進一步地分割為“最小部份”。而原子之“最小部份”乃構成宇宙間所有物質在概念上之基本單位。伊比鳴魯學派進一步地引申到時間和空間上，而得到這三種，“最小部份”之間有某種協調 (co-ordination)，亦即“最小部份”之物質，於“最小部份”時間中，佔據“最小部份”之空間。這種協調提供給伊比鳴魯哲學在了解宇宙時的一項基本參考架構 (referential framework)，並且得以描述任何物體在任何活動的常數。伊比鳴魯學派也因此得以其原子論之立場，來回答自 Zeno of Elea 以來對時間、空間、運動、靜止等所提出之種種挑戰 (Part II.6)。

得到如此之初步結論後，伊比鳴魯學派則更進一步地以其科學方法論來證明“最小部份”此概念的正確性，並設法定位其在本體論上的地位 (Part III)。接下來則繼續探討如此之觀見如何被引用到伊比鳴魯哲學的其他方面。本文以其物理學、數學和倫理學為討論重點。在物理學方面伊比鳴魯以及其學派設法回答傳統以來對原子論的質疑：原子在真空
(void)中，如以直線運動，則無法互相撞擊，而產生宇宙。伊比鳩魯學派大膽地提出原子在直線運動時有不可預測之偏離 (atomic swerve)，造成原子撞擊，而因之產生宇宙。當然如此的解釋必須付出代價，因爲原子不可預測之偏離，顯然和原子論中所隱涵的自然規律相抵觸。在數學上，伊比鳩魯及其學派則質疑歐基里得的幾何學。於倫理學，原子不可預測之偏離所帶來的意涵，否決了有命定論意涵的原子論，這就是伊比鳩魯哲學中的自由意志問題 (free will problem) (Part IV)。

這些引用以及延伸的結果，是伊比鳩魯哲學裡的過度化約 (reductionism) 傾向被充分突顯出來。為了科學解釋上的經濟考量，他們要求“最小部份”解釋過多的東西，而正是這樣的過度化約傾向，使得一個本來相當具有創意的“最小部份”物理構想，以及其所引射之斷歟性的 (discrete) 宇宙觀，功虧一簣。“最小部份”做為宇宙論之常數和不可預測之原子偏離並不相容，至於其引用至倫理學上自由意志之討論則純屬無謂之舉 (Part V)。
I. Introduction

The purpose of this essay is to make an inquiry into the physical concept of *minimae partes* -"smallest parts" - in Epicurus’ philosophy. *Minimae partes* are said to be the conceptual components of Epicurus’ atoms, and atoms in their movement are said to move sideways at the range of one *minima pars* without any antecedent cause and at unfixed time and place. All of these are threadbare cliches for the students of Hellenistic philosophy but a systematic elaboration of these well known facts remains in great need because most of the discussions concerned with this concept and its implications are either inadequate in their interpretations of sources or treat them as side issues with no intrinsic philosophical importance. My approach is to look at this concept of *minimae partes* from the perspective of "history of idea" and not only to examine, in a systematic way, its philosophical significance in the whole of Epicurus’ philosophy but also to adopt a diachronic view on its genesis and evolution. The latter view is particularly important because it is recognized now that a full understanding of Epicurus is impossible without taking into serious account the Eleatic, Abderite, Platonic and Peripatetic traditions¹. It is for this reason that I devote a rather lengthy part of this essay to a delineation of this history of influences and responses in regard to the Epicurean concept of *minimae partes*. The structure of this thesis is therefore composed of three parts, and each of them examines its different aspects. They are:

1 Genesis and evolution of the concept of *minimae partes*. In this part I shall try to trace the origin of this concept and, I think, the story has to start from Zeno of Elea. His paradoxes have evoked different responses from his successors and one of them was atomistic. Atomists

¹ Solmsen 263.
and their critics were not the only members of this philosophical choir with its tone set by Zeno. We also find academics and the very transparent Diodorus Cronus joining in but probably with their very different tunes to sing. Epicurus, allegedly, was at the end of this fruitful philosophical dialogue and the concept of *minimae partes* could be said to be developed in its final form with him. I therefore shall try to give a brief account of the individual contributions made by this choir of philosophers, which includes Zeno of Elea, the early atomists, the academics, Aristotle, Diodorus Cronus and Epicurus *cum* other Epicureans (Part II).

(2) Proof for the existence of *minimae partes*. I shall try to illustrate the implicit reasoning which might have prompted Epicurus to argue for the existence of *minimae partes*. This has been much neglected and I shall thus try to elaborate the whole argument slightly by borrowing some more formal analyses found in Philodemus’ *de Signis*. By this discussion I hope the ontological nature of the physical concept of *minimae partes* could receive more explanation than it has received so far because this will involve one in such a question: whether it is justified to reify *minimae partes* or not, and what implication it might have for Epicurean philosophy (Part III).

(3) Application of *minimae partes* in the philosophy of Epicurus. I subdivide this part into two areas of discussion. First, I will relate what I have argued in Part II and Part III to Epicurean physics and argue for the opinion that the concept of *minimae partes* is an authentic and integrated physical concept in Epicurean physics although this has never been explicitly mentioned by Epicurus himself. I shall then make an excursion into Epicurean anti-Euclidean stance on mathematics and try to indicate Epicurean consistent position on this controversy. In my second discussion of this part, the attention will be paid to the supposedly intimate connection between "free will" and "atomic swerve"
which Lucretius thought did exist. I shall approach this question from two radical directions, reductionism and anti-reductionism respectively, and reach a tentative conclusion that Lucretius was probably misleading and the concept of *minimae partes* was basically physical. Afterwards I shall give what, I think, would be the most plausible reason for Epicurus' introduction of atomic swerve, which presupposes *minimae partes*, into his discussion on free will (Part IV).

With this inquiry I wish to be exhaustive but realize that this is impossible. What one can find in this essay is perhaps a kind of mosaic, composed of exciting but scattered insights of scholars and some arbitrary opinions of my own, organized by an insistence on the philosophical significance of *minimae partes*. This always has the unfortunate side-effect of exaggerating my present topic out of its proportion. I therefore try to be balanced and always bear in mind what Epicurus says in *Ep. Hdt.* 69:

"All these qualities, I repeat, merely give the body its own permanent nature. They all have their own characteristic modes of being perceived and distinguished, but always along with the whole body in which they inhere and never in separation from it; and it is in virtue of this complete conception of the body as a whole that it is so designated" ².

This "body as a whole" is the whole Epicurean philosophy and I therefore devote Part III and Part IV to it and in fact these two parts cover epistemology, physics and ethics, a tripartition of Epicurean philosophy. The "body as a whole" is also the philosophical tradition Epicurus lived in and Part II is an effort on it. I wish my discussion

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² Translations of the original texts are based on items in the Primary Texts (of the Bibliography) on which the asterik * mark is placed.
will locate the concept of *minimae partes* properly in these two contexts and help illuminate, partially, the "permanent nature" of the "body as a whole" by my investigation of its *minimae partes*, that is, the "smallest parts".
II. Genesis and Evolution of Minimae Partes

II.1. The Eleatic Challenges: Zeno of Elea

Three points have to be briefly expressed about the historical importance of Zeno as regards present topic. First, I agree with most of the scholars\(^3\) that there was no so called Pythagorean atomism against which Zeno’s paradoxes were devised. Secondly, it is a safer policy to resist the temptation to attribute to Zeno a plan, an aim and a method in his paradoxes which the testimony from Plato’s *Parmenides* 127A-128E seemed to suggest. Supposing Zeno was a monist - which is not clear in fact - in defense of Parmenides’ monism as is embodied in his *The Way of Truth*, Zeno’s paradoxes can hardly be said to be ardent because a refutation of pluralism did not constitute a full justification for monism; in certain aspects, his paradoxes can be interpreted in a way which is fatal to both philosophical doctrines\(^4\). Thirdly, Zeno’s paradoxes did provoke the response of atomism, and it is the history of this response, criticism and readjustment that is my main concern in this essay. Therefore, in this analysis of his paradoxes, I shall concentrate on those points relevant to my exposition of atomism, *minimae partes* in particular. His paradoxes, in addition, are very instructive in furthering our understanding of continuum, divisibility and infinitude.

The first paradox I shall discuss is his argument against plurality. This argument contains two sub-arguments, and is allegedly derived from Zeno himself. One of them is stated in this way:

"If there is a plurality, things are both large and small, so large as to be infinite in magnitude (*apeira to megethos*), so small as to have no magnitude at all

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(methen echein megethos)\textsuperscript{5}.

This argument takes the form of if (P) there are many things, then (Q) they are so small as to have no size, and (R) they are so large as to be infinite, while the two propositions - if (P) then (Q) and if (P) then (R) - can not co-exist and are therefore contradictory. Such a pattern of argument was repeated in Epicurus’ \textit{Ep. Hdt.} 56-7. (Q) receives more elaboration in Simplicius \textit{in Phys.} 139.18-19:

"... he proves this after having first proved each of the many things has no magnitude from the fact that each is the same as itself and one."

This seems to refer to Melissus fr.9:

"And being one it must have no body (\textit{soma}). But if it had mass (\textit{pachos}), it would have parts and it would no longer be one."

A further reference is to \textit{Parmenides} 137 CD. A full argument for (Q) would be thus:

(Q1) if there are many things, each of them should have unity and identity;
(Q2) if a thing has body or mass, it would have parts;
(Q3) a thing with parts is no longer of unity and identity;
(Q4) thus if there are many things, none of them will have size.

(Q) is argued with Eleatic metaphysical doctrine in mind, and the fault with it seems to be the semantic confusion of the predicates 'one'.

and 'many' which are used in an elliptical way. On the other hand, the potential significance of (Q2) and (Q3) could be exploited in a way favorable to enemies of atomists. However, this is not clear.

The other sub-argument of this plurality dilemma is more interesting since instead of Eleatic doctrine it is conducted with the consequences which a supposition of infinitude might bring. In addition to (R) Simplicius in Phys. 141.2-6 reports:

"If it exists, each must have some magnitude and bulk; and one part of it must be distinct (apechein) from another. And the same story holds good for the outstanding part (peri tou prouchontos) - it too will have magnitude and part of it will stand out. Indeed to say this once is to say it always, since no such part of it will be last or not related as one part to another."

This proof will not make without a lemma being granted. It is that all corporeal existents must have size: "if an existent did not increase another when added to it, nor yet decrease it when subtracted from it, that existent could be nothing". With the proof and lemma put together (R) proceeds in this way:

(R1) an infinitely divisible existent contains an infinite number of parts.

Then according to the lemma:

(R2) each part, if it still constitutes an existent, must have some positive size.

Then with the implicit assumption that all these parts are put together:

6 Simplicius in Phys. 139.9; Aristotle Meta. 1001b7.
(R3) the aggregate of an infinite number of parts with positive size must be infinite in magnitude.

In fact there is a most vital but hidden assumption in (R2) which is:

(R2.1) a part with an infinitely decreasing size because of infinite division will have a minimum, though still positive, size.\(^7\)

However, if we, on the one hand, insist on the infinite division (R1) while on the other hand assert (R2) and (R2.1), then we fall into a contradiction. Simplicius did say: "no such part of it will be last." Therefore (R) seems to fail in its aim because we have no reason to negate (R1). The interest of (R) does not end with its refutation. (R) seems to presuppose an Euclidean geometry of space with the possibility of infinite divisibility and thus the plausibility of (R1). The impossibility to find the last term in this process of infinite division is bound to have some connection with the difficulty we shall find in the Zeno's paradoxes of Dichotomy and Achilles.\(^8\) It is not certain whether Zeno

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\(^7\) Both (R1) and (R21) are subject to the confusion about the following propositions:

(a) if there is a finite size and a body composed of infinitely many parts which are no smaller than this size and then the whole body must be infinitely large;

(b) if there is a body composed of infinitely many parts and each of these parts is of some finite and positive size, then the whole body is infinitely large.

In the present paradox, so it seems, Zeno took advantage of this confusion and imposed (a) instead of (b) on the interpretation of (R2) and (R21).

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\(^8\) Argument in this refutation does not consider the situation of what of the infinite division is finished with. Bostock in his review of Sorabji 1983 is apparently not satisfied with the solution that I learn from the latter (Sorabji 336-41) and suggests that the key to a solution of these paradoxes of infinite division is to deny Aristotle's claim that a line could not be made from points without magnitude, "provided there are 'enough' of them", with 'enough' defined as "more than a countably infinite number" (Bostock 262). However, Bostock thinks that the Greeks had never reached an adequate solution to this puzzle and this failure constituted a strong argument for atomism (Bostock 262).
held to an infinite division along a continuum since the whole (P), (Q) and (R) are dialectical in nature (can one expect Zeno to accept the lemma in (R)?) but the refutation of (R) does open the alternative that there could be a discontinuous space and physical bodies composed of smallest separable physical parts. Another interest is that Zeno, at least according to (R), did not have the concept of convergent infinitude, i.e., the sum of an infinite series of parts could be the limit on which the successive partial sums converge. In default of such a concept we cannot regard (R) as counter-intuitive but, on the contrary, this seems to be a very widespread assumption in ancient philosophy, particularly among the atomists, e.g. Epicurus in Ep. Hdt. 56-57. Aristotle sidestepped this problem by his potential infinitude which denied the actual realization of infinite division: "The infinite exists when one thing can be taken after another endlessly (aei), each thing taken being finite but always different," and then raised the examples of days and games in the process of coming to be and passing away. I cannot see how these examples could be really relevant to the infinitude in question and I suspect what Aristotle rejected was any physical exemplification of "a certain kind of the denumerably infinite."

There is another argument against plurality and it comes from Simplicius in Phys. 139.5-19 and 140.27-141.8. A relevant extract from it is this:

"If there exist many things, it is necessary that they be as many as they are and neither more than themselves nor

10 It is ironic because it is the atomists that should have never accepted the mathematical analogy of the argument because mathematical continuum is in direct conflict with a magnitude composed of discrete units and it is not known why they should have accepted the consequence of the supposedly mathematically infinite division of magnitude.
less. But if they are as many as they are, they will be limited. If there exist many things, the things that exist are unlimited. For there are always other things in the middle of the things that exist (metaxu ton onton) and again others in the middle of those. And thus the things that exist are unlimited."

The structure of this argument is that if (X) there are many things, then both (Y) they are limited, and (Z) they are unlimited. In the last argument, that is, (P), (Q) and (R), the contrast is between small and large (or nonentity and infinitude) while the present one is between limited and unlimited. What characterizes both is their concern for quantification and hence the moral lesson should be the same. I do not know if (Y) is a very sophisticated mathematical notion\textsuperscript{13} or simply an "uninstructive sophism"\textsuperscript{14}. What I am interested in is (Z). According to the Eleatic doctrine there exists no void and two different existents could only be separated by a third existent. Aristotle in his Physics 213b22-27 told us that Pythagoreans held void as a sort of separation that divided continuum, and it is not known if Zeno had this particular dogma in mind but this point was picked up by atomists. If what separates two beings is a non-being, then the regress could be stopped\textsuperscript{15} and what was being and non-being in the hand of atomists was transformed into atoms and void.

These two "arguments against plurality" which have been discussed so far are supposed to be authentic because of their origin from Zeno. For the following four arguments we have to reconstruct from Aristotle and his commentators and they are grouped under the heading of "arguments against motion," yet they, in their different

\textsuperscript{13} Vlastos 1967:371.
\textsuperscript{14} Barnes 1982:253.
\textsuperscript{15} Furley 1987:120.
respects, presuppose the implications found in the argument against plurality and they certainly have more comprehensive philosophical interest than the problem of motion. The first paradox among these four is Dichotomy. Aristotle is brief in this paradox and in his *Physics* 239b14\(^{16}\) it is said this:

"The first says that motion is impossible because an object in motion must reach the half-way point before it gets to the end."

With this Aristotle refers to his *Physics* 233a21. However, Simplicius in *in Phys.* 1013.4 gives us a fuller explication:

"... before it traverses the whole of the half distance, it must traverse half of the half, and again of this half. If these halves are infinite in number because it is always possible to halve any given length, and if it is impossible to traverse an infinite number of positions in a finite time..."

These two versions are different in one place wherein Aristotle’s runner could never reach the destination while Simplicius’ runner seems unable to start his journey. This sounds startling but the logical analysis of them should be the same, i.e., none is able to traverse a limited distance within a limited period of time. Another point is that Aristotle in his *Physics* 233a21 says: "... it is impossible... to make an infinite number of contacts (*hapasthai*) one by one..." What could this *hapasthai* mean? It could be "mental stopping"\(^{17}\) or counting and for that there is a support in *Physics* 263a7-11 but Aristotle could be polemical there\(^{18}\). A natural reading is to interpret it physically as

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\(^{16}\) = Lee 19.

\(^{17}\) Barnes 1982:263.

\(^{18}\) Cf. Pseudo-Aristotle *de Insecabilibus Lineis* 968a18.
physical contact with each point of division. In this way we could describe the runner as performing infinite number of tasks.

Let's base our analysis on the authority of Aristotle. Suppose the distance to be covered is from A to B, and the runner in traversing AB has to come the middle point M and then the middle point of MB, N, and *ad infinitum*. The paradox is thus:

(T) if the runner traverses his journey AB, he then has to perform an infinite number of tasks in order to finish it.

(U) it is impossible to perform an infinite number of tasks in a limited period of time.

(V) therefore the runner cannot traverse AB.

Aristotle made two objections to this inference. In *Physics 263a15-22* Aristotle proposed an *ad hominem* argument and the target is (U). He warned us not to mix up infinite length with infinite divisibility; in addition, if a limited length could be divided infinitely, so could a limited period of time. This reply is not adequate, as Aristotle admitted (*Physics 263a20-21*), because we have now to perform two impossible tasks instead of one. Aristotle (*Physics 263b3-9*) has another solution based on his pet idea of potential infinitude:

"... some one moving continuously traverses unlimited things incidentally (*kata sumbebekos*), not absolutely (*haplos*); for it is incidental to the line to be unlimitedly many halves, but its essence and its being are different."

It is a bit difficult to appreciate this argument fully without getting into his metaphysical labyrinth, but I suspect that this answer simply shifts our focus from infinity to "an extendable finitude"19.

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19 Sorabji 1983:323; for a criticism of this view, please see Bostock 263-65.
20 Sainsbury 13.
It is necessary to clarify a semantic confusion before we start to tackle this paradox. The metaphor of "traverse" or "run" in this paradox is used in a way very different from its usage in ordinary life, and this points out a very important fact, though illicitly concealed, that is, the paradox in itself is a mathematical translation of our ordinary description of race, and thus this paradox poses two different theses for these two descriptions of the same event. Owen says that for the mathematical description it posits (A1) that this race does have an infinite number of intervals to traverse, while for the other description it is this (A2) that such a distance is divisible infinitely but that such a division could never be completed. The connection between (A1) and (A2) is not factual and for our every failure to perform (A2) we can turn to (A1) and ask for a re-description. Owen blames what goes wrong is that we cannot find a final term for this sequence of tasks. If there is a final term in (A1), then we return to the contradiction mentioned in the last argument against plurality (R2), and ask for a "re-translation" but this is impossible. Since the mathematical translation is a "mistranslation," one can, through *reductio ad absurdum*, assert that it is not the case that no subsequent state of affairs is compatible with his having completed the series of tasks. The mistake of this Dichotomy is thus an imposition of (A1) on (A2). Owen's solution is a victory of ordinary language over the mathematical language but he also points out the moral of two thought-experiments related to the present paradox, "lamp" and "marble", which is that according to (A1) no consistent description exists of the state of affairs of the runner at the very end of this journey, and therefore allegedly there exists a discontinuity between the state of affairs of the terms within

22 Owen 1986:50.  
this limited series in the AB and final state of affairs which is B. This is the question concerning the last moment of the moving object coming to rest (or the first moment of resting object starting to move, according to Simplicius’ version) and the exasperation is that there seems to be no such moment in this paradox if AB can be infinitely divided.

However, it is this that gives a possible solution of Dichotomy. Let’s neglect the point B and reconstruct a class of points which is suitable in the sense that the new paradox represents the same difficulty as the original one. This suitable class of points has points arbitrarily close to B and the traversal across this class of points has no metrical difference from the traversal across AB. Every point is unproblematic for the runner to traverse and the only problematic one is B in this suitable class of points. However, when the runner wants to get to B, he has to traverse all the points in this suitable class and this constitutes a sufficient condition for his arrival at B. The same kind of argument, I think, can be applied to the paradox of Achilles, and Aristotle indeed said that Achilles was simply a dramatized version of Dichotomy. This paradox, according to Aristotle, is formulated in this way:

"This says that the slower will never be caught in running by the fastest. For the pursuer must first get to where the pursued started from, so that it is necessary that the slower should always be some distance ahead."

The argument could be conceived in this way. Suppose there exists a point P along the racecourse where Achilles tried to catch the tortoise, which is allegedly impossible. However, this only means that P is the point the tortoise could reach while Achilles could reduce infinitely the distance between his position and P, and this throws us

back to Dichotomy. The only difference between these two paradoxes is that the destination has already been defined in the Dichotomy while the \( P \) in the Achilles has to be calculated in accordance with the distance the tortoise has already proceeded and the relative speed between tortoise and Achilles.

However, there is more than one perspective to look at these paradoxes, and one of the more imaginative approaches is atomism. A long passage from *De Generatione et Corruptione* 316a10-317a12 is said to be derived from Zeno and in this passage the length in these two paradoxes is, by parity of reason, substituted by a body or bulk. If the body is divisible everywhere, the result would be infinite division into nothing or into points with no magnitude. However, we all know that there are finite bodies but the arguments show that they are not, and therefore we must reject one of the premises that leads to this absurd conclusion, and the most suitable one for rejection, because it is most controversial, is that body is infinitely divisible. Atomists in *G.C.* 316b28 proposed that there must be "indivisible atomic magnitude," a thesis negating infinite division. A similar response was also witnessed among the Platonists and in *De Lineis Insecabilibus* they put forward the "indivisible line" in reply to Dichotomy in particular\(^{26}\). Whatever "indivisible atomic magnitude" or "indivisible line" is, it alone could not solve the paradoxes of Dichotomy and Achilles. It will need something more, such as a correct description of jerky atomic motion, to solve the difficulty in finding the last term in the division of a magnitude. I hope I can elaborate these points in their proper places.

So far these two paradoxes we have just discussed are mostly confined to infinitude and division, and they are related to the problem of motion in the designation of the last moment of motion. The paradox of Arrow did break new ground, and it was exploited by Diodorus

\(^{26}\) Aristotle *Meta*. 968a18ff.
Cronus with such a significance in his analysis of time, space, matter and motion in general that it has been suspected that this paradox was devised by Diodorus Cronus but was fathered on Zeno later. This is unlikely as it seems to me. I would rather assume that Diodorus Cronus answered Zeno's Arrow under the guidance of atomism. Aristotle's testimony of this Arrow is brief and dismissive:

"... for if... everything always rests or moves whenever it is against what is equal (kata to ison), and what is travelling is always in the now (en toi nun), the travelling arrow is motionless"\(^{27}\).

and then he accused Zeno of "misargues":

"...This comes about from assuming that time is composed of 'nows' (ta nun); for if that is not granted, there will be no deduction"\(^{28}\).

Zeno's argument is that what a description is presumably true of an object at an instant is also true of it over any period of time while Aristotle, who refuses time to be discontinuous and composed of extensionless 'nows', denied this inference from components to whole. Furthermore, he argues that when we speak of "travelling" arrow, an instant or a 'now' fails to provide a necessary condition for motion, that is, duration. For Aristotle the term "motion at an instant" is simply self-contradictory. This contradiction is extended to rest at an instant: "at an instant, it is not possible for anything to be either in motion or at rest"\(^{29}\). However, this could not be the whole story. Owen says that motion 'for' an instant is senseless but it is possible to talk about motion 'at' an instant based on the possibility of talking of motion over a period of

\(^{27}\) Aristotle Phys. 39b5-7, = Lee 29.
\(^{28}\) Aristotle Phys. 239b30-33, = Lee 28.
\(^{29}\) Aristotle Phys. 239b1.
time. Owen warns us that although these two uses of motion are different they are systematically related\(^{30}\). Owen's charge is directed against both Zeno and Aristotle because of their mutual exclusion: on the one hand, Zeno might have complained that the instant was too short for motion but such a talk presupposed a period of time during which motion was possible; on the other hand, Owen criticizes Aristotle for his denial of motion at an instant and thus of velocity and this made increase or decrease of speed impossible and delayed the development of mechanics\(^{31}\).

A tempting solution to this paradox is to suppose that the instant is a "time atom", not atom in Democritean and physical sense but the conceptual *minima pars* (smallest part) and this period of time is composed of these "time atoms" and then one solves this paradox with all the philosophical implications such a "time atom" would bring\(^{32}\). There are two difficulties with this solution. One is anachronism but more serious is that this solution mixes up the "extensionless instant" with "time atom" which has positive duration. Another point deserves our attention is that thesis about the place of arrow as "against what is equal," and this could mean its immediate surrounding, and Aristotle did accept this thesis. What implications there could be for one who holds "time atom" and/or "the place of a body as its immediate surrounding" will receive exposition later. To anticipate the future development of atomism I shall say these. For atomists, if one changes the extensionless instants into *minimae partes* of time in the present paradox, they would agree that it is a correct description of motion and the conclusion of an arrow being motionless will turn out "having been in motion".

The fourth paradox is Stadium in *Physics*, too well known for one

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\(^{30}\) Owen 1986:60.

\(^{31}\) Owen 1986:61.

\(^{32}\) Please cf. the section on Diodorus Cronus in page 38ff.
to quote it. Aristotle thought the fallacy lay in an ignorance of relative motion. Such a fallacy seems not very exciting and some scholars wish to make more out of it, of whom the most influential one is Tannery who interprets each unit of these three blocks as indivisible. Suppose this is historically true, then the paradox would not only be that everything composed of these indivisibles must move at the same speed and, furthermore, they cannot move in the opposite directions\textsuperscript{33}, but also that each of the blocks will pass each other by one unit at one go and this is the famous "jerky motion" of atoms\textsuperscript{34}. All of these bizarre results would appear when one comes to \textit{minimae partes} in Epicureanism and so this paradox of stadium anticipates the later development of atomism\textsuperscript{35}.

From our analysis of these paradoxes a recognition of the wide-ranging implications inherent in them for the development of atomism is essential. They laid down most of the topics which friends and critics of atomism would elaborate and transform. The two arguments against plurality are mainly about the possibility of infinite division of a continuum, while the other four paradoxes, which are said to be about motion, have to presuppose their discussion. In Dichotomy and Achilles the condition for the application of the concept of infinitude becomes the major concern and this will inevitably result in the inquiry into the first or last moment of motion and this in turn will have implication for the moment of change from one situation to another and for the perfect-tensed description of motion. The Arrow shares these interests but also introduces the topic of time; the Stadium sooner or

\textsuperscript{33} Bicknell 61.
\textsuperscript{34} Sorabji 1983:331.
\textsuperscript{35} There are two other paradoxes, one of which - space - might have influenced the concept of void in Epicurus' philosophy (see D. Sedley "Two Conceptions of Vacuum" \textit{Phronesis} 27 (1982):175-93); the other one - sorites -imitated Diodorus Chronus in his conception of movement as composed of amere somata (Sextus \textit{A.M.} X 113-7, = Doering 129; Sedley 1977:92-3).
later, if it is interpreted in an atomistic way, will be understood as conveying the message of jerky motion. The importance of Zeno's paradoxes thus cannot be exaggerated, and the history of atomism is a series of vigorous responses to this set of agenda. We shall discuss pre-socratic atomism in the next part. It is they that pointed out the general direction for the later atomists to follow.

II.2. The Pre-socratic Atomism

Pseudo-Galen said that Leucippus of Abdera was a pupil of Zeno of Elea36. This is difficult to confirm. When we turn to what we know about his doctrine Leucippus apparently made his effort to reply to the challenge posed by Zeno. To say that atomists tried to reply to Eleatic challenge is in fact to prejudice their relationship37 but on this specific question, as I will argue, our main sources confirm this relationship. G.C. has a passage which bears witness to Leucippus' attempt to "save phenomena" and making a new doctrine that phenomena would not be possible without void:

"... He agrees with sensible appearances to this extent, but he concedes to those who maintain the One that there would be no motion without void, and says that what is void is not-being, and no part of what is is not-being-for what is in the strict sense is wholly and fully being. But such being, he says, is not one; there is an infinite number of them, and they are invisible because of the smallness of their mass. They move in the void (for there is void), and when they come together they cause coming-to-be, and when they separate they cause perishing"38. (my underlining)

38 Aristotle G.C. 325a23-32.
Those words underlined reveal the Eleatic trace in atomism. Leucippus' proposal of void as non-being is not only a clear reply to Simplicius in Phys. 139.5-19 and 140.27-141.8 (already mentioned in page 12-13) but also describes the context of atomic motion. A few lines before this passage we have a description of this atomic world:

"... If someone thinks the universe is not continuous but consists of divided pieces in contact with each other, this is no different, they held, from saying that it is many, not one, and is void..."

These two passages proved the intellectual link between Eleaticism and atomism. However, we wish to be more specific on the connection between Zeno and the first generation of atomists. A passage from G.C. 316b28-317a2 again confirms this connection but I want to quote a more controversial one:

"Some gave in to both of these (i.e. Eleatic) arguments - to the argument that all is one if 'what is' means one, by saying that not-being (me on it) exists, and to the argument from Dichotomy, by positing atomic magnitude".

Simplicius in his commentary mentioned that Alexander and Porphyry both referred 'some' to Plato and Xenocrates; Simplicius refused to endorse Plato as a candidate because Plato's me on it was a me on it. However, it is plain that only atomists posited both void 'and' atomic magnitude and so the 'some' ought to indicate the atomists and therefore the pedigree of atomists seems more certain.

In our discussion on Zeno's paradoxes we mention that Zeno's arguments, pros et cons, assume an infinite division along a contin-

40 Nicol 1936:121 & note 1.
uum, and this kind of division and the paradoxes it generates could be blocked if what exists is divided into indivisible magnitudes:

"Now if you divide part by part, the breaking will not be unlimited, nor can it be divided at every point at the same time (for that is impossible) but only to a certain point". 42

This passage presumes a pair of contradictory propositions: (A) some body is everywhere divisible and (B) every body is composed of indivisible atoms, and the logic form of G.C. 316a12-317a14 is a *reductio ad absurdum* of (A) and thus (B) is established as true. This passage also puts into doubt the contiguous nature of the divided and raises a further question, which is whether the indivisible magnitudes are physical or mathematical. As we know from ancient atomism, there are an infinite number of atoms, each eternal, solid, indivisible, with positive magnitude, different in sizes and exhibiting infinite kinds of shapes. These characteristics seem physical for the most part but the division of length, space and body ought to remind us of the possibility of mathematical division. Aristotle seemed unaware of such a distinction in the early atomism 43 and some later testimonies for its existence could be projected back on Leucippus and Democritus. I believe a nondistinction between the physical and mathematical interpretation of the indivisible could accommodate most, if not all, of the evidence, and an examination of the more partisan evidence will show that this line of interpretation does not exclude the other possibilities. I shall begin with a passage where both physical and mathematical indivisibles are implied but apparently not differentiated.

"Except that Leucippus and Democritus think that imper-

viousness (apatheia) is not the only reason for the first body not being divided, but also smallness and lack of parts (to smikron kai ameres); but Epicurus later does not think them partless, but says they are atoms through imperviousness.\textsuperscript{44}

First, 'imperviousness' is apparently a physical quality but the smallness of atom, according to Epicurus, is conceptual. For the "lack of parts" (ameres) Epicurus substituted his minimae partes instead, and this is a conceptual notion — this will be argued later — and shows the awareness of a distinction between physical and conceptual (which is more comprehensive than mathematical) division in Epicurus, and thus constitutes a clarification of his predecessors' view. Leucippus' and Democritus' atom is therefore both physically indivisible and, implicitly, conceptually indivisible; but no effort had been made to tell them apart.

There are more partisan evidence. We only examine those pieces of evidence which claim their indivisibles as conceptual. Simplicius in his comment on de Caelo 271a9-11 reported that Democritus "by introducing a smallest overthrows the greatest part of mathematics" and the same kind of accusation was leveled by Aristotle himself in de Caelo 303a20-4: "it is necessary that those who talk of atomic bodies clash with the mathematical science." There are some other evidence about this conflict between mathematics and atomism, and if there is a conflict it would mean that these atoms are mathematical, and the conflict would play in the form of continuous geometry (or Euclidean geometry) \textit{versus} granular geometry (= atomist geometry) and infinite divisibility \textit{versus} limited divisibility. Later in the passage just mentioned Aristotle complained that atomism would ruin his concept of motion and time which was based on his idea of continuum. The

\textsuperscript{44} Simplicius in \textit{Phys.} 925.13-17.
first thing to say about his accusations is that there is no direct denial of physical indivisibles although atoms with different shapes and sizes would be embarrassing to any kind of mathematics. Secondly, Barnes suggests that, since most of the accusations were either directly or indirectly derived from Aristotle and Aristotle’s mathematics is geometry applied to the physical world, the conflict in fact existed in the domain of physics rather than mathematics. Thirdly, between the age of the pre-socratic atomists and Aristotle existed the notion of conceptual indivisibles held by Platonists, and Platonists had a high claim on mathematics, and thus Aristotle might have his own ax to grind, in particular his combat against Xenocrates. In G.C. 316a5-9, Aristotle separated those who painstakingly collected facts from those who merely conducted unfounded speculation and easily reached any conclusion without any qualm, and the latter were apparently meant to be Academics. After all, the most obvious excuse for one to suspect that atomists were heretical mathematicians was their argument against infinite divisibility in the Dichotomy and other paradoxes of Zeno, but it is not improbable that they did take the physical division at its face value. This opinion has the support of a passage from 187a1-3 already quoted and another one from G.C. 316b28-317a2:

"necessarily indivisible atomic magnitudes inhere in it, particularly if generation and destruction of objects through dissociation and association. This is the argument that seems to necessitate the existence of atomic magnitude."

If we remember the context wherein this passage appears is closely connected with Zeno’s paradoxes and the process described in the quotation is a physical one, then the atomists did take the division as

45 Barnes 1982:357.
physical. We are not obliged to give any independent weight to Simplicius' and Aristotle's evidence concerning the alleged conflict.

None of those arguments will be satisfactory without facing two most mathematical examples attributed to Democritus. They are 'cone'\textsuperscript{46} and 'spherical angles'\textsuperscript{47}. We do not have Democritus' answer to his puzzle of 'cone' but it is more probable than not that whatever answer he might have in his mind a mathematical one was very unlikely.\textsuperscript{48} As for the 'spherical angles' it seems involved in a false application of the method of exhaustion by Antiphon in squaring the circle, and by this analogy a sphere is a polyhedron with infinite or many angles. Simplicius reported:

"The sphere is an angle; for if what is bent is an angle, and sphere is bent at every point on its surface, then it is reasonably called a whole angle".

These two examples are too ambiguous for one to say anything definite, and mathematical examples devised by atomists do not necessarily imply that the nature of atoms in their atomism has to be mathematical.

In this section I have tried to show that the first step was taken by Leucippus and Democritus, in terms of atomism, in their solution of Zeno's puzzles and they did not tell clearly physical from conceptual indivisibles, and after weighing evidence I tend to think that the physical nature of their atoms was more predominant but this did not exclude their conceptual nature. In fact, the lack of distinction does help accommodate all the evidence in this section. This distinction is nevertheless vital for the later development of atomism and minimaee

\textsuperscript{46} Plutarch 1079E.
\textsuperscript{47} Aristotle \textit{de Caelo} 307a17ff.
\textsuperscript{48} For a full discussion on this "cone" problem, see D.E. Hahm "Chrysippus' Solution to the Democritean Dielemma of the Cone", \textit{Isis} 63 (1972) pp.205-20, and Sambursky \textit{Physics of the Stoics} pp.92-98.
II.3. Indivisible Magnitude in the Academy: Xenocrates

The reason why I have to mention the distinction between physical and conceptual indivisibles is that such a distinction is vital to any future development of atomism. Without a conscious grasp of the "conceptual" indivisibles, no atomistic construction of time, space and matter as well as its special view on atomic and jerky motion, no *minimae partes* with all the possible implications would be possible. Historically, it is Platonists who first emphasized the conceptual indivisible. The difficulty with it is that the sources we have are not always consistent and are by nature polemical in most cases. My attention will be paid in particular to the pseudo-Aristotle’s *De Lineis Insecabilibus*, which was said by some to be a work of Theophrastus but obviously was an Aristotelian reply to the conceptual indivisible formulated by the members of the Academy, probably with the particular target of Xenocrates in mind. With this criticism we somehow know what the indivisible line of his Academic enemy looked like.

Some of the most important evidence about this conceptual indivisible are:

1. *Physics* 187a1 has been discussed and despite some commentators and Nicol, the people who gave in to *to me on* and the indivisible magnitude were more probably the atomists rather than Plato and Xenocrates.

49 Luria is said to establish a two-tier theory for Democritean atoms. His main evidence is Alexander in *Meta*. 3625-7 in which mere somata were said to be in the atoms and only graspable by mind. A discussion on this suggestion could be found in Sorabji 1983:357. It is certainly unwise to disregard all kinds of evidence but it is probable that Alexander might well have made a mistake here.
(2) *Metaphysics* 992a19-24:

"... from what principle will the presence of the points in the line be derived? Plato used to object to this class of things as being a geometrical fiction. He called the indivisible lines the principles of lines (or Furley's translation: 'the starting point of a line' (ekalei archen grammes...tas atomous grammas)) - and he used to lay this down often."

The context is mathematical or, more comprehensively, conceptual, and the conceptual indivisible is in the form of indivisible line. Nicol, following Stenzel, suggests that what was particularly in Plato's mind was an attempt to solve the problem of continuity and Plato's conception of this problem was such that he was bound to reach this conclusion\(^5\). This will receive more exposition later.

(3) *De Lineis Insecabilibus*. The numerous references to mathematics in this treatise and the nature of these mathematical statements seem to show that this work belonged to the first successor(s) of Aristotle\(^5\); some effort has already been made to establish close relationship between this work and *Physics* VI. My impression of reading is that it looks like a practice work done in the Lyceum by a disciple who knew the irrational number and spared no time to display this knowledge. The discovery of irrational number at that time was really a fatal blow to conceptual indivisible. Five arguments for the existence of conceptual indivisible are listed in *De Lineis Insecabilibus* and require separate a brief examination.

(3a) 982a2 is an attempt to make an inference from ordinary language, such as large *versus* small or many *versus* few, to the existence of definite measures as their criteria and these had to be indivisi-

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50 Nicol 1936:122.
51 Heath 1921:347.
ble lines and indivisible magnitudes in general. This way of argument was later picked up by Lucretius in his De Rerum Natura I. 615-27 and in Plutarch 1079A-B.

(3b) 968a9 is to introduce the Platonic form of line and mix it with indivisible line because both in their own aspects are prior in nature to the same object and therefore they must be identical. What surprises one is that despite the title of De Lineis Insecabilibus the indivisible "magnitudes" in this work have much wider application and includes triangle, square and other stereometrical objects. This point has some connection with 992a19-24 and will receive discussion later.

(3c) 968a14 is a bit unintelligible to me but it runs roughly like this: If elements are prior to body and parts (which were meant ultimate and indivisible parts) are prior to the whole, then elements, such as fire, should be endowed with those features which characterize those parts and therefore become indivisible.

(3d) 968a18 is a Platonist's response to Zeno's paradoxes, Dichotomy above all, which prompts Nicol to refer "some" in Physics 187a1-3 to Plato and Xenocrates, and, since Dichotomy is about infinite division of a line, it seems natural to put up indivisible line in reply. As for the reason why an infinite division is impossible, Platonist thought it is because this would entail infinite counting and was thus unacceptable.

(3e) 968 b4 is rather similar to (3a) but is more mathematical. The supposition in (3e) is that all lines must be commensurable but this would be impossible without a basic measure by which all line are integral multiples. This is astonishing because the discovery of irrational number ought to have made Platonists cautious in this question, but Platonists might have thought that this indivisible line as a

52 Proclus 279.
measure with which "physical line" has to compromise anyway; this only means that Platonists had to jettison indivisible lines in mathematics at least if they are not prepared to 'physicalize' mathematics or, more properly, geometry.

I guess these five arguments, full of confusions, were mainly the brainchild of Xenocrates, and the most peculiar feature of indivisible line is that it ranges through ideal, mathematical and physical worlds despite all the possible inconsistencies this mix-up might have generated. Sorabji, nevertheless, thinks this is a step beyond Plato who seemed to have a less extravagant interest in this topic\textsuperscript{54}. Furthermore, based on (2), (3b) and some other evidence, Nicol, following Stenzel, suggests that Plato and his disciples might have attempted to build up an ordered system of limits because archai and perata had been so often used as synonymous in this treatise. Along the spectrum of this system one extreme end is the metaphysical principles of One and Great cum Small while at the other end is this perceptible world; in the interval is mathematical object\textsuperscript{55}. Each grade holds the possibility of extending into the neighboring - either higher or lower - grade, and thus every line is an indivisible surface and surface the indivisible solid. Simplicius in \textit{in Phys.} 142.25 reports: "Plato said that surface was the first and minimal solid." Each transition is the arche of the next stage and peras of the old one. This graduation of mathematical objects seems not unusual as a passage from D.L. VII 135, which is about the stoic Apollodorus, looks quite parallel to this suggestion:

"Body (soma) is defined by Apollodorus in his physics as that which is extended in three dimensions, length, breadth and depth... surface is the extremity (peras) of a solid body... a line is the extremity (peras) of a surface..."

\textsuperscript{54} Sorabji 1983:358 & 362.
\textsuperscript{55} Nicol 1936:123-4.
a point is the extremity of a line, the smallest possible mark or dot (semeion elachiston).\(^{56}\)

Therefore, the contribution of Academy is their distinction between physical and conceptual indivisibles, and their more prominent attention to the latter. This sounds very paradoxical because I have just said that Xenocrates mixed up together ideal, mathematical and physical indivisibles, but the case seems not so. A clear distinction among these three kinds of ontological entities had always been mandatory in the Academy; the ordered system, if it ever be, is basically conceptual. When I say that there is a mix-up, we find that the mix-up in (3b) is mathematical with ideal indivisibles but they are both at least conceptual, and if a distinction between physical and conceptual indivisibles is required we are glad to find that Xenocrates separated (3a) from (3e). Xenocrates might seem rather nebulous to us but he knew the vital distinction.

II.4. Aristotle

Aristotle occupied the pivotal role in the development of minimae partes and his contributions lay in his insighted criticisms of atomism held by Leucippus and Democritus. His criticisms evoked very vigorous and imaginative responses from Diodorus Cronus and Epicurus. Since we have mentioned his testimonies now and then, we shall therefore center on two aspects of his analyses which were most influential in the history of atomism. They are:

1) the possibility of organizing these sub-sensible atoms into the sensible objects we are aware of, or, in other words, the construction of the simples into the complex;

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(2) the possibility of atomic motion and the referential framework within which this motion happens.

We shall tackle (1) first. Aristotle in Physics 226b19-227b2 proposed three ways of arrangement:

(a) contact (haptomenon): "Things are said to be in contact when their extremities are together (hapathesthai de ton ta akra hama)"\(^{57}\).

(b) succession (ephexes): "A thing is in succession when it is after the beginning in position or in form or in some other aspect in which it is definitely so regarded, and when further there is nothing of the same kind as itself between it and that to which it is in succession."\(^{58}\)

(c) contiguity (sunekes): "A thing that is in succession and touches is contiguous."\(^{59}\).

I list these three ways of arrangement of simples into complex because of their importance and later we shall return to them often. Aristotle seemed to think that this was an exhaustive list of arrangements of smaller units into larger ones. He also set priority among them with this order: succession, contact and then contiguity, because each of the latter ones has to presuppose the former in definition\(^{60}\).

In Physics 231a21-b18 he applied these possibilities of arrangement to a criticism of atomism. From what we know about (a) and (c) Aristotle seemed to think either akra or eschata, which were in contact or overlapped when the objects to which they belonged, were counted as parts of objects, while atoms were by definition magnitudes without parts. Aristotle could therefore question if it was possible to create a sensible object out of these indivisible and sub-sensible magnitudes with no part whatsoever. The difficulty with Aristotle's demonstration is that of the three examples he gives us two are about extensionless

\(^{57}\) Aristotle Phys. 227a7.
\(^{58}\) Aristotle Phys. 226b34-227a1.
\(^{59}\) Aristotle Phys. 227a10.
\(^{60}\) Aristotle Phys. 227a20.
geometrical point and temporal 'now' (the third is about motion and will have our attention very soon), and he did not hesitate to formulate his argument in a general term: "the same reasoning applies in the case of all indivisibles"\(^{61}\), and these indivisibles include basic units in time and space. If we leave aside the false analogy between extensionless point (and now) and the extended atom and emphasize the partlessness of atom alone, then Democritean atoms are indeed vulnerable to such a criticism. Aristotle in 231b12 said: "nothing continuous is divisible into things without parts," and in 231a16 said: "everything continuous is divisible into divisibles that are always divisible," and did not think that the claim of Democritean atoms as "apatheia" was valid when these Democritean atoms were of different magnitudes and shapes. According to Simplicius, Epicurus at least agreed with part of Aristotle's criticism: "... Epicurus retained their apatheia but dropped their partlessness since they had been refuted on this ground by Aristotle"\(^{62}\).

Aristotle's criticism of the partlessness in Democritean atom is in fact not quite to the point. Apart from the false analogy already mentioned, Aristotle committed another mistake, that is, the extremities of an atom did not necessarily constitute parts of an atom, neither did the extreme point of a line part of the line. Thus an atom could have extremities without thereby having parts and therefore the criticism from arrangement was invalid. However, one may ask further: how about a fourth possibility of arrangement? or why Aristotle seemed to have forgotten an application of his "succession" in his criticism of atomism? I believe Diodorus Cronus and Epicurus did not overlook this loophole and, so far as I know, Epicurus did take advantage of this oversight for his 'conceptual' minimae partes while retaining

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61 Aristotle Phys. 231a31.  
the arrangements of contact and contiguity for his 'physical' atoms. This is Epicurus' two-tier theory for his atoms: atoms are indeed physically 'uncutable' further but are nevertheless divisible further into conceptual parts, called *minimae partes*. In this way we could see how the later atomists by their responses to Aristotle's criticism could have made their atomism more adaptable and sophisticated.

It is time now to tackle (2). Intellectually speaking, this is probably the most exciting breakthrough in the history of atomism and would certainly have not happened without Aristotle. His point is that an assumption of atoms would inevitably result in a very special way of atomic motion and this in turn presupposed a certain co-ordination among time, space and matter, which constituted the framework for this type of motion. In *Physics* 240b8-241a6 Aristotle said this:

"We assert that a thing without parts cannot move except incidentally, for example by being present in a body or a magnitude which is in motion .... Let us assume that it changes from AB to BC... and let the primary time taken by the change be D. Now at the time when the change happens it must be either in AB or in BC, or partly in one and partly in the other; this is true of everything that changes. But it cannot be partly in each of the two, because it then would have parts. Nor can it be in BC, since it will then have changed (*metabeblekos*), whereas our hypothesis is that it is changing (*metaballein*). It remains that it is in AB at the time when it changes. So it will be at rest, for to be in the same place or state for a time is what we mean by 'to rest' (*eremein*). It follows that a thing without parts cannot move, or indeed change at all. The only way in which it would move is if time were composed of 'nows' (*ei ho chronos en ek ton nun*); for in any 'now' it would have moved or changed (*aiei gar en toi nun kekinemenon*
and so it would never move but always have moved.\(^{63}\) (my underlining)

This interesting passage mentions that a body, which is an indivisible magnitude without distinction of parts, if it is in motion, entails the indivisibility in time and, as in *Physics* 231b18-231a12, such a body would entail indivisibility in length or space. Besides, the words I double-underline reveal that any true description of movement must take the perfect tense. In fact, before the argument of 231b18-231a12 Aristotle has already announced:

"The same reasoning applies equally to magnitude, to time and to motion: either all of these are composed of indivisibles and are divisible into indivisibles, or none."

What this co-ordination could mean but that one atomic unit of magnitude traverses one atomic unit of space in one atomic unit of time, and this indicates that all indivisibles of matter must be the same in speed. Later Epicurus inferred from this marvelous physical thesis and suggested another no less extraordinary one, i.e., atoms being composed of *minimae partes* must be of equal velocity in the void. Sorabji suggests that this criticism of atomism by Aristotle could be relevant only against the background of conceptual indivisibles although Aristotle seemed unaware of this distinction in his present criticism. This could well be witnessed in his mix-up of extensionless nows and points with the extended atomic time and magnitude. What the later atomists could do is to accept the contour of his argument but clarify all the different elements involved.

In this exposition I might have given the impression that atomic time is at the end of the entailment among matter, space and time, but

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\(^{63}\) Aristotle *Phys.* 240b8-241a6.
in 232b20-233a12, 233b19-33 and 235a22-24 Aristotle intended this entailment to be mutual and the denial of atom in time automatically constituted a refutation of atom in space and matter. He used the "out-of-phase-clock" to prove this mutual entailment, the detail of which is not of my present concern. At least one person, Strato of Lampsacus, did not think that atom in space and matter had to entail atom in time but for the future development of atomism this grand co-ordination among time, space and matter in atomist terms was assumed as true by Diodorus Cronus and Epicurus.

This co-ordination among time, space and matter produced a very interesting but counter-intuitive consequence, that is, atomic motion could only proceed in a jerky way. For at every time atom if we examine each state of affairs of a 'moving' body, the result is a paradox that motion is composed of a series of rests, just like Zeno's Arrow. One of the reasons for the static or finished nature of the state of affairs of an atom is because of the idea: during a 'time atom' nothing is supposed to change, not even the time itself. In such a situation we can only say that a stretch of magnitude has moved with a jerk to the next atomic stretch of space after an atomic stretch of time and repeated the same pattern of disappearance and reemergence again and again. This result would certainly influence our description of motion; instead of present tense (‘moving’) we now have to use perfect tense (‘having moved’) to describe the motion if we want to be faithful to our inference. Diodorus Cronus was unruffled by this result and designed more paradoxes to overcome its prima facie strangeness. Epicurus, furthermore, would accept this as a legitimate scientific inference and defused its paradoxical nature by arguing that those atomic

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64 Sorabji 1983:367.
67 Bostock 269.
magnitude, time and space existed conceptually and were far below the ken of our vision and thus were not susceptible to empirical falsification. As far as our observation of phenomenon was concerned, the motion of perceptible object appeared continuous. This jerky and perfect-tensed motion also has some impact on the first or last moment of motion and rest. These will receive their elaborations in due places. Aristotle's criticism forced atomists to be more sophisticated and to widen their inquiry into more possibilities.

II.5. Diodorus Cronus

Diodorus Cronus belonged to the Dialectical School. This school together with Megarian and Eristical Schools, according to Sedley, were titles attached at different times to different groups of philosophers conventionally regarded as Euclids' heirs. His formal philosophical allegiance was, like Megarians, to Eleatic doctrines and he seemed to cast himself as the second Zeno. He devised, like Zeno, four paradoxes against motion (or more properly, "a body can not be in motion but has always moved". It is therefore necessary to ask what his opinion about those ideas he received as well as innovated. Was he merely dialectical and simply waited for the next round to refute the ideas he gave in the first place? Or were they dogmas he held onto? It is indeed difficult to make a decision, but in Sextus A.M. II. 86 it is reported:

"Thus this man (i.e. Diodorus Cronus), in trying to support his own dogma, has admitted what is an absurdity; for how is it other than absurd to say that while nothing moves something has moved? But the skeptics, being equally in doubt about being in motion and having been

68  Sedley 1977:75.
69  Sextus A.M. II.85.
in motion, will not assent to any absurdity, such as Diodorus has admitted."

Thus, at least according to Sextus, Diodorus has his own view on motion and was dogmatic\textsuperscript{70}. This judgement is certainly not final because one cannot put too much faith in Sextus, a skeptic, whose job was to see everyone as dogmatic in his assertion and was always ready to suspend (\textit{epoche}) every philosophical doctrine, including a 'dialectical' one. However, for our present purpose the importance of Diodorus Cronus is not so much his own feeling about what he said - which is very illusive - as the very fact that his doctrine was accepted by Epicurus\textsuperscript{71} and others as a part of authentic atomism. If I have sometimes called him an atomist, I have used it as shorthand label, \textit{minus} the qualification "according to Epicurus and other Epicurean atomists".

The first contribution of Diodorus Cronus to atomism was his recognition of the importance of conceptual indivisible for atomism. He was said to be responsible for the substitution of "partless bodies" (\textit{ta amere somata}) for atoms\textsuperscript{72}. Its significance has to be realized. Apparently, his \textit{amere somata} were basically physical, as one would agree after a quick review of all the testimonies collected in Doering. There are, however, two further pieces of evidence which indicate that his partlessness could also be conceptual in substance. Aetius, \textit{via} Stobaeus, reports that both Xenocrates and Diodorus Cronus defined the \textit{minimae partes (elachista)} as partless\textsuperscript{73}. Xenocrates' indivisibles, as I have shown, ranged over the physical and conceptual worlds and he was recognized as the innovator of this distinction. The fact that

\textsuperscript{70} Long & Sedley 1987 vol. II: 48.
\textsuperscript{72} Doering 116; Furley 1967:13.
\textsuperscript{73} Doering 117B.
Diodorus Cronus was named together with him should suggest that he share the same view. Simplicius in Phys. 926.19-21 also reports that Diodorus Cronus thought 'nows' and 'units' (*hai monades*) were partless\(^{74}\). Both were more than likely to be regarded as of conceptual partlessness. Most of all, the atomic motion with all its implications, which Aristotle flushed out and Diodorus Cronus accepted, required conceptual indivisible as a necessary assumption since the irregular and physical Democritean atoms would not do this job. Diodoran *amere somata* therefore could be understood as a reaction against Democritean atoms and the term of 'atoms' had to be dropped in favor of *'somata'* because of its semantic association with the theory of Democritus. If this reaction were true, the difference between Diodorus Cronus and Democritus in regard to their partless bodies and atoms is that Diodorus was aware of the distinction between physical and conceptual indivisibles but Democritus was not. Such a distinction is vital for Epicurus because his atoms as physical indivisibles were a legacy from Democritus and were of different shapes and sizes, but as regards *minimae partes* he had to find similar units that "composed in a conceptual way" atoms and thus had to presuppose a further conceptual division within the physical indivisible. We do not know if Diodorus' *amere somata* are different in their shapes and sizes, but so long as the basic units in magnitude, space and time were similar, then we can say that he preceded Epicurus in accepting that there might be different sizes of atoms or *amere somata* while there also existed in a conceptual and sub-atomic way the so called *minimae partes*.

I have mentioned that Zeno's Arrow was suspected to be the brain-child of Diodorus Cronus but was later fathered on Zeno. I denied that attribution but said that Diodorus Cronus' philosophy would have welcome that description of the Arrow's motion. Apart from *Physics*

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\(^{74}\) Doering 120.
240b8-241a6 and 231b18-232a12 I shall quote another passage from Sextus *A.M.* wherein we can find very similar way of analysis and use of language but with a slightly different conclusion:

"If a thing moves, it moves now; if it moves in the present time, it moves therefore in an indivisible time (en amerei chronoi). For if the present time is divided, it will certainly be divided into the past and future, and thus it will no longer be present. And if a thing moves in an indivisible time, it passes through indivisibles, and it does not move. For when it is in the first place, it does not move; for it is still in the first indivisible place. And when it is in the second indivisible place, again it does not move but it has moved. Therefore nothing moves."

The last sentence is an ill-disguised Zenonian imitation, and the argument is clearly reminiscent of Zeno's Arrow. The question in this quotation is: how can we defy the ordinary expression that "something is moving"? Diodorus Cronus' response was to raise two examples from our ordinary life and proved that a perfect-tensed description was the true description of state of affairs that a "moving" object obtained. They are the perfect-tensed "Helen has had three husbands"75 and "These men have married"76 but I have to confess that I have failed to see much merit in these two examples, except his confidence that he must be right. Another one is more significant and indeed original. The example is in Sextus *A.M.* II.10177:

"Let a ball, he says, be thrown onto an overhanging roof. Then at the point of time that is midway in the throw, the proposition 'the ball touches the roof' is false; for it is still on its way. But when it has touched the

75 Sextus *A.M.* II.98.
76 Sextus *A.M.* II.98.
77 = Doering 123.
roof, the preterite 'the ball has touched the roof' becomes true; therefore it is possible for the preterite to be true when the present is false, and therefore for a thing not 'to be moving' in the present but 'to have moved' in the preterite."

This example is persuasive only if one accepts Diodorus Cronus' partless time; it also points out the thorny problem of the first and last moment of motion and rest. In Zeno's Dichotomy I have mentioned that one of the puzzles inherent in it is how to grasp that last moment of motion and a solution of that problem is the key to a solution of that paradox. Since Diodorus Cronus denied infinite division and accepted jerky and perfect-tensed description of motion, he could deny the state of affairs wherein an moving body kept on approaching to its last moment of motion because that last moment could never exist for anyone who espouses infinite division and certainly not for Diodorus Cronus who totally denied any unlimited divisibility. For him the state of affairs of amere somata was static in the partless unit of time within that partless space and then disappeared to have another state of affairs re-emerged in the next unit and so forth. When we apply Diodorus Cronus' vision to the Dichotomy or Achilles, the runner can only be said to "have reached" his destination and before that state of affairs is said to "have not reached", a totally discontinuous and different state of affairs.

Another example by which Diodorus could prove his case is "when the wall is destroyed". The conclusion of that example is that "the wall does not perish," another Zenonian disguise; he would have only accepted the conclusion that "the wall has perished." This atomistic insight into the last moment of motion could be extended into a general

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78 Sextus A.M. II.347, = Doering 126.
thesis on change but this did not receive his attention as far as the extant testimonies about him are concerned.

So there is a co-ordination among partless time, space and matter\textsuperscript{79}, and every mass of matter must fill up "at least" one atomic space since there is no atomic space partly occupied. Sorabji has suggested\textsuperscript{80} that at least one definition of space by Aristotle would force him to accept the jerky atomic motion and all its consequences, i.e., the definition that the place of a thing is nothing but its immediate surrounding or, in Aristotle's word, "place is coincident with the thing, for boundaries are coincident with the bounded"\textsuperscript{81}. We find an argument of Diodorus Cronus in Sextus \textit{A.M.} II. 87-89 could be used against Aristotle though the target of that argument is not specified.

There is a curious passage from Aristotle's \textit{de Sensu} 449a20-31 about the gap between the furthest of visibility and the nearest of invisibility which cannot be identical. Two passages of Alexander's commentary on this question\textsuperscript{82} say that this problem was first raised by Aristotle but was taken over and exploited by Diodorus Cronus. Sorabji\textsuperscript{83} thinks the gap is the atomic length; Denyer\textsuperscript{84} and Sedley\textsuperscript{85} think this gap is the smallest visible and is probably used as an analogy for the partless indivisible which is only conceivable, and they are probably right. The perceptible minimum, as an analogy for the conceptual minimum, also indicates that no question about shape of the perceptible minimum - and so conceptual minimum - can be raised and this is vital to the arrangement of the perceptible or conceptual minima in the perceptible object or in the mass of atoms of which they are compo-

\textsuperscript{79} Sextus \textit{A.M.} X.121-2.
\textsuperscript{80} Sorabji 1983:18 & 370.
\textsuperscript{81} Aristotle \textit{Phys.} 212a30.
\textsuperscript{82} Doering 119.
\textsuperscript{83} Sorabji 1983:371.
\textsuperscript{84} Denyer 36-7.
\textsuperscript{85} Sedley 1977:86-7.
This is a response to Aristotle's doubt if partless components could be organized into a complex. This idea was later taken over and refined by Epicurus in his argument for *minimae partes*.

An assessment of Diodorus' contributions has to start from the great extent of his debt to Aristotle. His achievement lay in his appreciation of the Platonists' conceptual indivisibles (if we follow Sorabji's suggestion) and Aristotle's destructive insights. Nevertheless, an accommodation of both elements under the general guidance of Democritean atomism in his hand transformed a primitive doctrine into a positive and rather sophisticated philosophy. His contributions, however, remained scattered and waited to be incorporated into a system. Whether this had been achieved by Epicurus is a subject for the rest of this essay.

**II.6. Epicurus and the Epicurean School**

In this part, I shall discuss the historical intellectual linkage of Epicurus' atoms and his *minimae partes* with his predecessors. Whatever scientific justification Epicurean atoms and *minimae partes* could have had and whatever functions they might have served in physics, mathematics and ethics, are questions for the following parts of this essay.

The two-tier theory of Epicurus' atomism, as I have mentioned, is a compromise between Democritean atoms and Diodoran *amere somata*. From Democritus Epicurus learned that atoms had to be of infinitely different shapes and sizes because the variety of phenomena dictated this assumption, but he reduced the infinity in sizes and

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87 It has been suggested by Mau that the mode of speech discussed in this "Master Argument" might have some relevance to the problem of infinite division of a magnitude. I, however, fail to see any relevance here and agree with Denyer 35-6.
shapes to the "incomprehensibly numerous". This is necessary if he wanted his atoms to be in consistence with the *minimae partes* which compose them. This is a point which we shall discuss later. From Diodorus he learned, on the one hand, that a clear distinction between physical and conceptual indivisibles was necessary, and the basic *ta amere somata* (= *minimae partes* according to Epicurus) in matter, time and space have to be similar; in addition, he accepted Diodorus Cronus' response to Aristotle's criticism of atomism and all its implications. The result of this integration of his predecessors' insights is that Epicurus created two kinds of indivisibles, physical and conceptual, that composed his atoms: he divided conceptually the physically unsplittable atoms, which were of different and innumerable sizes, into *minimae partes* which were all of equal measure in all aspects but only in a conceptual way. By this feat he gathered the scattered insights of Diodorus Cronus in a more systematic way.

First, a few remarks on his atoms. His assumption of physical indivisibles was an extension of the conservation principle and his response took the form of physical consideration against the possible consequence of infinite division. His arguments were similar to Zeno's arguments against plurality:

"we do not make everything weak and be compelled by our conception of complex to grind away existing things and waste them away into non-existence."

The aggregate of infinite number of particles would result in being infinite in magnitude. These are elementary fallacies on Epicurus' part and we do find that Lucretius tried to rectify these errors.

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This can hardly be said as an improvement since it assumes that all infinities would be equal\textsuperscript{94} but it is not totally counter-intuitive.

This physical indivisible, atom, is still divisible but now only in a conceptual way. Epicurus in \textit{Ep. Hdt.} 58-59 used an analogy between visible minimum and conceivable minimum to prove the "existence" of \textit{minimae partes}\textsuperscript{95}. This reminds me of that passage from \textit{de Sensu} about the gap between furthest visibility and nearest invisibility, and let's see how Epicurus exploited this idea:

"...even the idea that atom has a size was predicated on the analogy of the things before our eyes, by our simply projecting something small onto a large scale"\textsuperscript{96}.

But what is projected after all?

"We must consider the minimum perceptible by sense as not corresponding to that which is capable of being traversed (\textit{tas metabaseis}), i.e., is extended, nor again as utterly unlike it, but as having something in common... though it is without distinction of parts. But when from the illusion created by this common property we think we shall distinguish something in the minimum, one part on one side and another part on the other side, it must be another minimum equal to the first that catches our eye..."\textsuperscript{97}

This is an inference from the sensible to the non-sensible, and what are true descriptions of the sensible are also true of the non-

\textsuperscript{92} Cf. Zeno's P, Q and R arguments in II.1.
\textsuperscript{93} Lucretius I.615-27.
\textsuperscript{94} Rouse-Smith 51, note e.
\textsuperscript{95} I bracket the word, existence, because the ontological status of minimae partes is a question that has to be argued through.
\textsuperscript{96} \textit{Ep. Hdt.} 59.
\textsuperscript{97} \textit{Ep. Hdt.} 58.
perceptible but conceivable minimum, and they include:

(1) the *minima pars* admits of no division of any kind;

(2) the *minima pars* in itself admits of no traversal, i.e. is not extended, and, with the teaching from *de Sensu*, no question about its shape and size could be raised;

(3) *minimae partes* have their own special way of arrangement.

(1), (2) and (3), as they seem to me, were put forward willfully as replies to Aristotle’s criticism in *Physics* 226b19-227b2 and their admission of no traversal, partlessness and shapelessness could offer a chance for Epicurus to escape all geometrical objections. (3) proposed an alternative to the three ways of arrangement in Aristotle’s list but was very similar to ‘succession’ (*ephexes*) which Aristotle had never deployed against atomists. Such an alternative was called ‘*hexes*’ by Epicurus:

"... we see these minima one after another (*hexes*), beginning with the first, and not as occupying the same space; nor do we see them touch one another’s parts with their parts, but we see that by virtue of their peculiar character (*en tei idioteti tei heauton*) they afford a means of measuring magnitudes (*ta megethe katameetrounta*): there are more of them, if the magnitude measured is greater; few of them if the magnitude measured is less. We must recognize that this analogy also holds of the minimum in the atom ..."

In this passage we find the fourth feature of *minimae partes*:

98 Cf. Lucretius I.609-10.
(4) they are the basic units of measure.

This thesis received some elaborate exposition in Lucretius II 478-99, in which, on the one hand, he argued that the component minimae partes of an atom could not be unlimited in number and on the other hand the permutations and combinations of these minimae partes can only produce limited atomic shapes. Therefore we have another characteristic of minima pars:

(5) The number and combination of minimae partes decide the size and shape of atoms.

However, there is a tag at the end of Ep. Hdt. 59 and it is read:

"... a process of composition out of the minima with their own movement is impossible."

This is a point where Epicurus thought the analogy between perceptible and conceivable did not hold, but its full significance was elaborated by Lucretius in his I. 630-634:

"Lastly, if nature the maker had been accustomed to compel all things to be resolved into their smallest parts, that same nature could no longer be able to make anything out of them, because things which are not augmented by any parts cannot have what generative matter must have - the variety of connections, weight, blows, concurrence, motions, by which all things are brought to pass."

This is an important passage which helps us define the ontological status of minimae partes and I have a few comments to make:

(a) "Things which are not augmented by any parts cannot have..."
Minimae Partes in Epicurus' Philosophy

seems to be a test for the existence of things, and its similarity to the lemma in the second argument of Zeno against plurality is not accidental. All things can be called existent in the full sense if they have mass.

(a) certainly has implication for the ontological status of minimae partes and from this we derive:

(6) The existence of minima pars is conceptual and not physically real; a sensible complex cannot be built from these conceptual minimae partes but from the physical atoms.

(c) The test for existence mentioned in (a) seems to indicate a close connection between parts and all the various features which characterized atoms. Minimae partes, being partless, are deprived of all those positive features which atoms are endowed with. Most of the characteristics minimae partes have can at most be said as negative. Therefore, there is an ontological hiatus between atoms and minimae partes and this must have some implication for the explanatory force which minimae partes could assume in relation to the perceptible world which atoms compose.

(d) Aristotle in Physics 240b8-241a6 said that "that which is without parts cannot be in motion except accidentally." This gives us a clear idea why Epicurus and Lucretius denied minimae partes the ability of motion in the two passages just quoted; they do have it but it is not of "their own".

Although Epicurus' atoms are physically unsplitable they are conceptually divisible to the minimae partes, Aristotle's criticism is thus invalid. With (1) to (6) we begin to have an inkling grasp of the definition of minimae partes. Parallel to the arguments about the minimae partes in atoms, we know from Lucretius an independent argument about the minimae partes in time. It is in IV. 744-6 and runs like this:

"...in a single time during which we have perception, there are hidden many times whose existence is discov-
This is again a use of analogy and an inference is made from perceptible minimum in time to its conceivable counterpart. Sedley is also reported to have identified an Epicurean reference to minimal time (chronos elachistos)\(^{101}\). With the proposal of minimae partes in matter and time it has clarified the ground for Epicurus to venture into those theories which the dialogue between Aristotle and Diodorus gave birth to. We do have evidence that Epicureans, which ought to have included Epicurus, accepted all the implications of minimae partes.

"He posited something like this. The thing happens whenever, from the place where this one changed, at the next (hexes) time, which is a minimal time, the neighbouring one will follow at once."\(^{102}\)

This looks like a jerky motion, and both time and moving body are presupposed to behave in co-ordination. But the next one is more explicit, and Simplicius mentioned that it originated from Aristotle. We quote the extract concerned with atomism:

"... the Epicureans say that magnitude, motion and time are all made of partless constituents, and over the whole magnitude composed of partless constituents the moving object moves but at each of the partless magnitudes contained in it it does not move but has moved..."\(^{103}\)

The "partless constituents" are a legacy of Diodorus Cronus; the co-

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102 Demetrios of Laconia, quoted from Sorabji 1983:373.
103 Simplicius in Phys. 934.25-29, also cf. 938.17-22.
ordination among time, space and matter together creates the referential framework for the jerky and perfect-tensed motion of an atom. An argument similar to this one can also be found in Sextus A.M. II. 142-54. This quoted passage also points out a very important message that there are two ontological considerations, one in the atomic level ('has moved') and the other in the phenomenal level ('moves'), of an object in motion, and we shall see later that both are true for Epicurus. Not any one of these two descriptions monopolizes the reality of motion.

The grand co-ordination was the product of a fruitful dialogue in the philosophical tradition that was first initiated by Zeno of Elea. Epicurus and his disciples accepted it, but Epicurus clarified those ambiguous elements in Diodorus and thus preserved the best part of his philosophy. We did not talk much about his intellectual linkage with the early atomists such as Democritus and Leucippus since the only possible link, Nausiphanes, is no more than a name to us\textsuperscript{104}, particularly on the question on minimae partes; nevertheless, Epicurus stuck to the general direction the early atomists had laid down. However, his acceptance of minimae partes will inevitably force him to revise some vital points in the pre-socratic atomism and this is a topic which awaits our exploration in the following parts. In the end, he tried to harmonize a very robust materialistic approach to the study of nature with a more speculative and abstract reasoning. The pivot of these two strains of thinking is minimae partes, and for our next task we shall examine the scientific methodology by which this pivotal concept is justified.

\textbf{II.7. A Summary of Part II}

A summary is now due for this historical survey of the genesis and evolution of minimae partes. We have devoted a rather lengthy account

\textsuperscript{104} Huby 80-86, Sedley 1976b:134-6, De Lacy 174-5.
to Zeno of Elea because it is he who set the agenda for the development of atomism and *minimae partes*. His arguments against plurality were concerned with division, continuum and infinitude and these concerns became the implicit assumptions for his four paradoxes recorded in Aristotle's work. Dichotomy and Achilles are about the infinite division of a continuum and the paradoxical result following this process must convince atomists that something must have gone wrong with this infinite division along a continuum. The atomists' alternative is to put forth a different view on the nature of things - a magnitude must be composed of some indestructible and basic units - and this has to imply a denial of infinite division at the same time. This alternative also points out a right direction for a satisfactory solution of both paradoxes, that is, how to define the first and last moment of motion. Such a moral lesson was made explicit by Diodorus Cronus in his example of the bouncing ball and perishing wall. Zeno's Arrow introduced the element of time into atomistic discussion and together with Stadium they had great implication for the description of atomic movement.

Aristotle's dealing with these paradoxes and atomistic arguments made explicit all the interesting points, but for a sophisticated atomist his criticisms seemed rough and ready and had to be clarified by a careful analysis of the concepts involved if his critical insights were to be turned to positive usages and incorporated systematically. Therefore, the distinction between conceptual and physical aspects of atoms was not known by Leicippus and Democritus but after Xenocrates it became mandatory for any would-be atomists. Aristotle's critical insights and academics' distinction were thus harmonized at the hand of Diodorus and were later incorporated by Epicurus as an integrated part of his philosophy. The six features therewith I have tried to characterize *minimae partes* were extractions from this choir of challenges and responses among Eleatics, Abderites, Platonists, Aristotleians and
Epicureans. Epicurus' claim to fame in this history of *minimae partes* was to a great extent based on his full appreciation of his predecessors.
III. Epicurean Proof for *Minimae Partes*

In my historical survey of *minimae partes* I have tried to examine the genesis and evolution of this concept within the context of Greek philosophy and have presented this concept as the fruit of a vigorous dialogue. In this part of our inquiry we shall shift our attention to the rationale which licenses Epicurus to argue for its existence and this means that we shall have to mention some of the most relevant points in Epicurean scientific methodology in relation to our present purpose. I believe the *de Signis* of Philodemus, besides Epicurus’ own *Ep. Hdt.* and other more accessible texts, is going to help us to understand this question in more explicit terms.

To begin with, let’s examine those four passages which bear a direct relation to the proof for *minimae partes*. These four passages are from (1) Lucretius I. 599-634, (2) Aristotle’s *de Sensu* 449a20-31, (3) Philodemus’ *de Signis* 54 and, by far the most important of all, (4) Epicurus’ *Ep. Hdt.* 56-59. My approach is to structure these four passages together and allocate each of them in their proper place in an argumentative form which I regard as a most appropriate proof for the ‘existence’ of *minimae partes* and then assess the logic force in this chain of arguments. This chain of arguments for the existence of *minimae partes* consists of three parts:

(A) *Ep. Hdt.* 56-7. Granted that there are parts in any finite body, the number of them has to be limited. Whether these are physical parts (“unless...we make all things too weak and... be driven to pulverize the things that exist”), or theoretical parts (“Nor... is it possible by such a progression to arrive in thought at infinity”), Epicurus is at this stage deliberately ambiguous or open-minded on whether the division should either be physical or theoretical. We shall find in (B) that both

kinds of division are taken into account. (A) is an attempt to establish the premise for its definition of the relationship between whole and its parts, i.e., the sensible minima constitute the psensible whole, but we shall find some other functions of (A) later.

(B) *Ep. Hdt.* 58-9. This passage elaborates further this attempt to establish premise in (A). The relationship of the sensible and the sensible minima was refined as a series of contrasts: traversal vs. non-traversal, distinction of parts vs. no distinction of parts, contact and contiguity of the sensibles vs. the *hexes* of the sensible minima, the sensibles as things measured vs. the sensible minima as measures and other common and different properties\(^{106}\). This part of (B) I shall call (B1). It together with (A) constitutes the premise in an inference. As for the rest of (B) which I shall call (B2), Epicurus extended this analogy between the sensible and sensible minima to that between atom and its minima:

"it is only in minuteness that it differs from that which is observed by sense, but it follows the same analogy (analogiai de tei autei kechretai)."

This analogy is not the concept-formation in *Ep. Hdt.* 32 but is instead a form of sign-inference. Such an inference from a perceptible minimum within a perceptible to a conceptual minimum within an atom will serve Epicurus’ purpose only if it is joined with an empiricist theory of what is conceivable: just as I can perceive that the sensible has its minimum, so I ‘must’ conceive that an atom has its minimum, and what the logical force this ‘must’ has has to be assessed. Here in (B2) we have in fact three inferences involved:

(B2.1) is from the sensible to its sensible minimum,

\(^{106}\) *Ep. Hdt.* 58.
(B2.2) is from the sensible to atom and
(B2.3) is from atom to its minima pars.

All of them share the same feature that they are inferences from what is known to what is unknown and what is apparent to what is non-apparent, and these constitute argument of sign-inference (semeiosis) which takes us from a sign to what it signifies; or in a more specific sense: "since X is P, Y is P", i.e., the ground of this entailment is X resembling Y in P. Epicurus says

"we must by all means stick to our sensations (aistheseis)... and similarly to our actual feelings (pathe) in order that we may have the means of determining what needs confirmation and that which is obscure (hopos an kai to prosmenon kai to adelon echnomen hois semeiosometha)"\(107\).

Even more explicitly in Philodemus:

"[one ought not to stop with evident things] but from them make inferences about the non-apparent, and one should not mistrust the things exhibited through them by analogy but trust them just as one trusts the things from which the inference was made"\(108\).

(B2.1) and (B2.2) are clearly from what is apparent to what is non-apparent; the atom in (B2.3) has no independent quality which is directly perceptible for us but through (B2.1) and (B2.2) its existence is proved ("on the analogy of things within our experience we have declared that atom has magnitude") and can thus be accepted as apparent and acting as a sign because minima pars now becomes the signi-

108 Philodemus frag. 2.
fied in the sign-inference of (B2.3).

On what ground one can justify this sign-inference and what kind of force the inference from a sign to what it signifies are questions which require a full exposition and will soon be discussed. It is in (B2) that I would like to insert the passage from de Sensu because its gist amounts to the same thing as (B2.1), and Sedley indeed says "the context suggests he is thinking of one which argues from the existence of a perceptible minimum to that of an intrinsically partless magnitude..."\(^{109}\) I also think Lucretius I 599-634 could be attached to (B2) since it is basically a paraphrase of the sign-inference argument in Ep. Hdt. 58-9.

(C). In (B) the inference, based on analogue, is applied to the proof for minimae partes, but from Philodemus' de Signis 54 we realize that this application of analogy has to be double-checked by ouk antimarturesis (= "not being witnessed against"): 

"... It is not enough to accept the minimal swerves of the atoms on account of chance and free will; one must also show that no other clear perception conflicts with this view (alla dei proepideixai kai to med’ allo hen toutoi machesthai ton enargon)."

Though it is the atomic swerves that are mentioned here, at least one scholar says explicitly that this can also be applied to minimae partes within atoms\(^{110}\) and we shall find atomic swerve has to presuppose minimae partes for its existence\(^{111}\). This indirect form of verification is particularly important in those situations wherein the signified

\(^{109}\) Sedley 1977:87; although his discussion is on Diodorus Cronus, it is clear that it could also be applied to Epicurus. Cp. Denyer 36; contra Sorabji 346-7.


cannot be verified by empirical tests.\textsuperscript{112} Thus (C) is vital not only for the proof of atoms and void but also, as we shall see, for the minimae partes. It is necessary to remind ourselves that this indirect form of verification is nevertheless subordinate to the inference in (B2) as Sextus says in A.M. VII. 216: "... the base and foundation of all is the evidence of sense." The relative importance of these two forms of argument in (B2) and (C) in fact is not so straightforward and we shall have to make their relationship more clearly defined later.

With (A), (B) and (C) I have, hopefully, placed these four main pieces of evidence in their proper contexts and formulated the argumentative form for the proof of minimae partes in the following way: (A) and (B1) are to seek for proper apparent and known phenomena as the premise for (B2), and then (B2) is to set up the inferential relationship between the premise and the non-apparent or unknown conclusion; (C) is to check, by means of ouk antimarturesis, the conclusion reached in (B2).

The next task is to fulfill those promises I have made in (B2) and (C) and thereafter try to extract more contributions from (A) to the proof of minimae partes. In (B2) we have asked ourselves on what ground a sign-inference from something known to something unknown is valid, and a rough and ready answer for it is that this could be done either by Epicurean 'inconceivability' or by Stoic 'anaskeue'.\textsuperscript{113} I wish to illustrate their respective claims by examining a debate between them on motion and void which is found in de Signis, and thereby point out those most relevant elements in Epicurean methodology which bear a direct relation to the proof of minimae partes.

Philodemus in de Signis 13 reports:

\textsuperscript{112} Philodemus de Signis 23; Sextus A.M. VII.216.

\textsuperscript{113} I leave anaskeue untranslated because of the complications that might be involved in any decision. A discussion on this terms, please see Sedley 1982:245 ("elimination"), Barnes 1988:99-100 ("rebuttal") and De Lacy ad loc ("contraposition") which is assumed without discussion.
"For we obtain the knowledge that if there is motion, there is void, by no other means than by establishing through the method of analogy that it is impossible for motion to occur without void. Thus we first determine empirically all the conditions attendant on moving objects in our experience, apart from which we see nothing moved; then by this method we judge that all moving objects in every case are moved similarly; and this is the method by which we infer that it is not possible for motion to occur without void."

This passage illustrates very well the empirical method of Epicurean inference from sensations to things which by nature can not be perceived directly. The terms in this inference are objects, not propositions, and the logical form of this inference is the so called 'inconceivability':

"... it is inconceivable (ou dunatai... noeisthai) that the appearance exists or is such as it is (enarges uparchein) and the unperceived object (adelon) does not exist, such an argument is not by anaskeue but by analogy (kath' homoieta), by virtue of which it is not possible to conceive that the appearance exists or is such as it is and the unperceived object does not exist or is not of such a nature, just as it is impossible to conceive that Epicurus is a man and Metrodorus not a man"\(^{114}\).

This passage in the present context is meant to form a contrast with the Stoic anaskeue which claims an 'intrinsic' relation between a sign and what it signifies and by the elimination of the signified the sign is co-eliminated as well. What the Stoics claim is that the elimination of

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\(^{114}\) Philodemus *De Signis* 19; cf. ibid. 21, 36, 45, 50 and 57.
motion is because of the elimination of void and because of that alone and the signified has the explanatory force with regard to the sign and the sign necessitates the signified\textsuperscript{115}. By contrast, the Epicurean analogy method by means of similarity could never ground this intimate relationship between the two terms in an inference, and the signified could never have such an explanatory force. What the Epicureans can do, according to \textit{de Signis} 13, is to claim the universal nature of their analogy:

"... the method of anaskeue, which in its entirety is made valid by and through analogy...."

This again is explained by an inference: "if Plato is a man, Socrates is also a man," which is said to be true because of inconceivability\textsuperscript{116}. I must say this is an inadequate example since both 'Plato' and 'Socrates' are sensible facts and can be tested empirically, but the 'void' in the last inference is not and cannot be tested in the same way and is thus meaningless to say of it as inconceivable if void is not assumed to exist. In fact, just before the inference from 'Plato' to 'Socrates' in \textit{de Signis} 17 Philodemus has already confessed that an inference from 'motion' to "void" conforms to the class of Stoic anaskeue but tried to impose its universal claim on 'all' inferences. What Philodemus (or Zeno of Sidon) can do, I surmise, is that any valid inference which proceeds by anaskeue has to be based on paraconditional (\textit{parasunenmmenon})\textsuperscript{117} proposition but this can only be established by a sign-inference which uses analogy or similarity:

"... if this method does not have the force to prove the inference, the method of anaskeue, which in its entirety is

\textsuperscript{115} Barnes 1988:99-100; Sedley 1982:245.
\textsuperscript{117} \textit{D.L.} 7.7.
\textsuperscript{116} Philodemus \textit{de Signis} 17.
\textsuperscript{118} Philodemus \textit{de Signis} 13.
made valid by and through analogy, is also without cogency\textsuperscript{118}.

This still leaves unexplained how Epicureans could monopolize the claim for necessity, and the remark in \textit{de Signis} 12 only makes Epicurean case more desperate:

"... we consider that our view is shown to be true even if we discover the analogy only in a majority of cases..."

The "in a majority of cases" gives the whole game away. This sounds very similar to the claim by Chrysippus for material implication for the art of divination, and what Epicureans can say at most is that such an inference established through analogy and empirical generalization is 'convincing' but 'not necessary'. This is an ideal short by far of \textit{Ep. Hdt.} 38 and Philodemus' \textit{frag.2}. Can Epicureans present their case in a stronger position?

Epicureans appeal to the "qua truth," a tactic they stole from their Stoic critics\textsuperscript{119}. The Stoic critics raise the possibility of colored and destructible atoms\textsuperscript{120} and then ask Epicureans a general question: "From what kind of similarity to what kind should one infer?" and warn that the similarity in an inference could either be essential or accidental\textsuperscript{121}, and the essential ones can only be established "through reason and inference from signs". Epicureans accept this challenge and try to define the properties they would use in an inference:

"Inference must not be made from any chance property common to any other, but from the property which gives

\textsuperscript{118} Sedley 1982:258.
\textsuperscript{119} Philodemus \textit{de Signis} 7.
\textsuperscript{120} Philodemus \textit{de Signis} 8.
no spark of evidence to the contrary and exerts no pull in opposition to things clearly perceived\textsuperscript{122}. 

This process has to be conducted empirically and not a priori as Stoic logos and anaskeue seem to imply\textsuperscript{123}. Though this process of finding is empirical, the Epicurean claim for their qua truth is that it is necessary. In de Signis 52 four senses of 'as such', 'insofar as' and 'according as' are distinguished and what characterizes all of them is "... 'of necessity' also follow on these terms...." This has been used by Barnes to argue for the necessary force of Epicurean analogy but this is an assertion inconsistent with qua truth. In effect, "insofar as Xs 'familiar to us' are P" is now used in the premise in an inference, and no wonder Barnes is puzzled at "how can similarity method establish these conditions [i.e. essences in the premise in an inference] in fact hold?" This is a repetition of the former difficulty wherein Epicureans try to replace anaskeue by inconceivability. The material implication, which Epicureans can at most claim for their inconceivability and their qua truth, seems embedded in their analogue inference. This indecision between an insistence on necessity and a recognition of its material implication - if the Epicurean inference is such a one - at least implicitly explains the very confusion we find throughout Philodemus' de Signis and, at the same time, calls forth the ouk antimarturesis in de Signis 54 which is rather unexpected in its context. In fact I suspect that the ouk antimarturesis in de Signis 54 is the Epicurean version of Stoic anaskeue. Sextus explains that ouk antimarturesis is "the congruity (akolouthia) of the supposed and opined non-evident object with the apparent"\textsuperscript{126} and what is implied in ouk antimarturesis of 54 is

\textsuperscript{123} Philodemus de Signis 35.
\textsuperscript{124} Barnes 1988:109.
\textsuperscript{125} Long 1988:143.
\textsuperscript{126} Sextus A.M. VII.213.
an epistemology that what is non-apparent resembles what is apparent unless there is a reason to suppose the existence of a difference\(^{127}\). With *de Signis* 54 Philodemus began to give up Epicurean analogy as necessary and true but simply as coherent and susceptible to potential falsification\(^{128}\). In fact we have seen the exercise of *ouk antimarture-sis* in *de Signis* 18 from which I quote a part:

"... the property which gives no spark of evidence to the contrary and exerts no pull in opposition to things clearly perceived."

Through my lengthy excursion into Philodemus' *de Signis* I wish that I have proved (C) as an intrinsic part of the proof for *minimae partes*, not subject to empirical test. What we have learned in our exposition can now be applied to those three analogies in (B2). For instance, (B2.1), (B2.2), and through them, (B2.3) are exercises of inconceivability. The *qua* truth can be seen in the careful definition of those features which an analogue inference wishes to carry from an apparent object in the premise to a non-apparent one in the conclusion, such as those features catalogued in (A) and (B1). As for the *ouk antimarture-sis* in (C), at first sight we seem totally at sea since *de Signis* 54 gives us no more than a reminder while the other sources of evidence leave us no clue at all. However, with the three inferences in (B2) and we find there a series of objects stretched from the sensible as a sign in (B2.1) at one end of the spectrum down to the signified atomic *minima pars* in (B2.3) at the other, and therefore these three inferences in fact constitute a quite 'big' inference. For an *ouk antimarturesis* to check this 'big' inference, in which the conclusion of the last 'small' inference becomes the premise for the next inference, we have (A) come to our

\(^{127}\) Asmis 1984:355, cf. ibid. 194-211.

\(^{128}\) Sedley 1982:269, Denyer 37.
rescue: "you must not suppose that there are parts unlimited in number, be they ever so small, in a finite body..." 129 This is a general principle running through every stage of this series of inferences and has to be said explicitly because an opponent could raise the possibility of an infinite parts, for example, in an atom which would then entail an infinite number of atomic sizes and variety of shapes, both of which are rejected by Epicurus. An explicit statement of this principle is thus not only an attempt to define the premises but also an implicit attempt to resist potential falsification of inferences 130.

Another example of 
\textit{ouk antimarturesis} is Epicurus’ refusal to endow \textit{minima pars} with the ability of motion and certain qualities. This caution is an attempt to stop the possibility that some qualities in the sensible minimum are carried over to the \textit{minima pars} ‘within’ an atom. In this way the principle of \textit{ouk antimarturesis} has been implicitly applied and constitutes an effort against any falsification and is a tactic to achieve the coherence of a concept. Therefore, we seem to have obtained an inkling idea of some dialectical interaction between the \textit{qua} truth, which gradually clarifies the terms in an inference, and the \textit{ouk antimarturesis}, which acts as a tool to test the logical coherence of the definitions of these terms involved in an inference; with every challenge from \textit{ouk antimarturesis} the definition of premise in an inference is forced to be tightened. It is no wonder that with such a dialectical effort to make coherent the concept of \textit{minimae partes} Lucretius was very carefully not to reify this concept:

"... it (\textit{= minima pars}) has never existed apart by itself nor will ever have the force to do, since it is essentially a part of something else..." 131

Both from the diachronic perspective, which I have tried in the Part II, and from the synchronic perspective, in Part III in which I wish I have illuminated from an examination of the Epicurean scientific methodology involved, the concept of *minimae partes* is an end product of an intellectual process to parry all possible criticisms that are ultimately derived from Zeno's paradoxes and to achieve conceptual coherence at the same time. Therefore, despite the shortcomings in this proof, we can realize that the thesis of *minimae partes* is more than an asserted dogma. How this concept is applied in Epicurean philosophy, especially in physics and ethics, will be our concern for the next part.
IV. Application of Minimae Partes

IV. 1. Application of Minimae Partes in Epicurean Physics and Mathematics

The historical survey of minima pars has shown that this concept is applicable to magnitude, space and time, and its embodiment in these three areas are coordinated in such a way that a minima pars of matter traverses a minima pars of space in a minima pars of time, and such a motion is jerky and its description has to be perfect-tensed. In the Epicurean proof for this concept we have also shown that this concept cannot be reified and minimae partes are thus deprived of all the various features an atom or a complex might have enjoyed and so they cannot be the physical components of the universe. However, the physical components are atoms and their various features can be described in terms of this conceptual minimae partes.

It is time to ask in what way this concept can be applied to the other parts of Epicurus' or Epicurean philosophy. This is urgent because most of the information on its application was derived from other sources than the Epicurean ones, and how to integrate this concept into the whole Epicurean philosophy and what kind of contribution it would make have to be argued out. I shall treat this problem of application under two headings, physics and ethics respectively, bearing in mind the always intimate relationship these two branches of Epicurean philosophy have. First, it is physics.

I have said that the concept of minimae partes entails the grand coordination among matter, space and time, and this in turn entails the isotacheia (= equality in speed) of minimae partes\(^1\). However, it is known that minimae partes as conceptual are not endowed with the abil-

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ity of movement, and it seems that a contradiction arises. Aristotle comes to our rescue as he says in *Physics* 240b8-13:

"... that which is without parts cannot be in motion except accidentally, insofar as the body or magnitude to which it belongs is in motion... or a part may be in motion in virtue of the motion of the whole".

Atoms are composed of limited numbers of the conceptual *minimae partes* in various combinations and, since these conceptual units are of *isotacheia*, atoms should also be of equal speed in the void. This has been questioned by Bicknell¹ and his argument is conducted in this way. An atom which is composed of X *minimae partes* has to wait for X *minimae partes* of time before it jerks to the adjacent spatial quanta composed of X *minimae partes* of space ("provided they always find a passage suitable to their size,"¹⁴), and such a state of affairs in an atom would repeat itself again and again so long as this atom continues its motion without the intervention from atomic swerve: atoms with different sizes and shapes presumably behave in the same pattern but with different periods of time for the next jerk."¹⁵

This argument, I think, is not correct and I have two points to comment. First, the description of the atomic behavior from the perspective of *minimae partes* by Bicknell presupposes that an atom composed of X number of *minimae partes* entails that time and space are to be atomic stretches in the same way, but this is not true. My own description is that the shape and size of an atom are physical facts but time and space are not bound by them. Let's suppose that there is an atom of Y *minimae partes* which are arranged in a vertical way, and, if it moves downwards, we shall record (Y-1) times of its disappearance

¹ Bicknell 1983:60.
¹⁵ For a chart that describes the movement of atom, please see Sharples 1996:41.
and re-emergence when the top *minima pars* occupies the space of bottom *minima pars*. The second point is that Bicknell's description does not entail that *isotacheia* of atoms is impossible. Suppose there are two atoms composed of X and Y number of *minimae partes* respectively and both X and Y *minimae partes* are arranged vertically and let them move from, *per impossibile*, the same height in the void at the time T. They might have different behaviors, if we follow Bicknell's description, at the beginning of their motions but at T+Z (Z is the minimum common denominator of X and Y) *minimae partes* of time, their relative position would be the same as at T and their speeds remain the same. This complicated situation is resulted from Bicknell's description but, if my own description is correct, these two atoms should have always been in the same relative position throughout their motions as they are at the time T. Therefore, I wish I have established that the *isotacheia* - *per impossibile* - of *minimae partes* necessarily implies the *isotacheia* of atoms. In fact, the situation is very simple: those *minimae partes* constituting an atom have to move in the same direction as the atom does since they derive their motion from it, and the minimae partes can be said to have *isotacheia* under this condition. It is instructive to compare this phenomenon with a compound made of atoms which have independent motions and we do know that Epicurus warned us not to make an inference from the motion of compound to that of atoms that comprise it. I shall say that this argument is only one of the three arguments for atomic *isotacheia* in Epicurean literature and one of the other two is paramount for the integration of *minimae partes* into Epicurean physics as I shall try to establish in the next paragraph while leaving the third to the note\(^{136}\).

In *Ep. Hdt.* 43-4 Epicurus tells us that atoms were moved by blows

\(^{136}\) Lucretius II.294-307 and Pseudo-Plutarch *Stromateis* 7.175 (= D.K. 68 A 39). These two passages are argued with the principle of sufficient reason in mind.
and rebounded or vibrated back "to whatever distance their inter-linking allows them to recoil from the knock". In *Ep. Hdt.* 61-2 individual weights of atoms cause them to move downwards provided they are not prevented by blows and change their courses. Whatever the causes by which atoms are moved, atoms must be of *isotacheia*:

"Nor will either their upward motion or sideways motion caused by knocks [be quicker], or those downwards because of their weights"\(^{137}\).

This is mandatory because (1) the nature of void is unable to provide any resistance\(^ {138}\) and thus gives way in an equal fashion for the heaviest as well as the lightest\(^ {139}\) and (2) atoms are entirely solid with their weights and unobstructed by any impact. Even when atoms are squeezed together, they either rebound over great distance or are tossed over short space from the impact\(^ {140}\); as far as the speed of atoms is concerned, it remains constant. This atomic motion can not be inferred from the motion of compound because such an inference would assume that all the component atoms are moving in the same direction within the compound but this cannot always be the case. The speed of atomic motion is described in graphic terms such as "[traversing over] any imaginable distance in an unimaginable time (\textit{pan mekos perilepton en aperinoetoi chronoi suntielei})" or "as fast as thought (\textit{hama noemati})"\(^ {141}\). What do these metaphors amount to and what is its relation to the one \textit{minima pars} of space per one \textit{minima pars} of time? These questions have to be answered if the concept of \textit{minimae partes} is to be integrated into Epicurean physics.

There is a clue to their solution and in *Ep. Hdt.* 62 we find:

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137 Cf. Lucretius II.84-5.
138 *Ep. Hdt.* 44.
140 Lucretius II.97-9.
"Now it will also be said in the case of compounds that one atom is faster than another, where they are in fact of equal velocity, because the atoms in the compounds move in a single direction even in the shortest continuous time (kata elachiston sunechē chronon), although it is not single in the periods of time seen by reason (kata tous theoretous chronous)...."

This is a very controversial piece of evidence even for one who is determined to establish close connection between atomic motion and minimae partes, and my own interpretation is this. First of all, there is an inference in this passage and Epicurus warns us of the risk from the apparent to the non-apparent in this case. Secondly, "the shortest continuous time" and the "periods of time seen by reason" are supposed to form some kind of contrast in the sense that the former indicates the shortest time-span within which one can perceive the continuous motion of a compound (and thereby infer, wrongly, that "the atoms in the compounds move in a single direction") while on the other hand the latter suggests what the reality of atomic motion is: the plural noun in "kata tous theoretous chronous" indicates a record of atomic motion in its direction being kept at every minima pars of time during the "observation" by reason. I have to admit that this reconstruction is very shaky and open to challenge and I therefore bracket it in doubt. However, I have found another evidence more obvious than Ep. Hdt. 62 and it is:

"... When the solid and uncompounded primary particles travel through empty void, and are both unimpeded from outside and being such a unity of its own parts (ipsa suis e partibus unum) borne hurtling downwards..."\[142\]

\[142\] Lucretius II.157-9.
The context does not require the phrase, "being such a unity of its own parts," to carry its message across; its appearance seems to suggest an deliberate elaboration on Lucretius' part to tell his readers some extra knowledge about atomic motion with the *minimae partes* which constitute the unity of an atom. This is a more positive evidence and it seems not too far-fetched to assume the existence of such a connection of which we are in quest. Furthermore, according to the epistemological principle of *ouk antimarturesis* there is no empirical test to falsify minimae partes and its connection with atomic motion.

With *minimae partes* established as an authentic part of Epicurean physics we can envisage that in the infinite void, so far as the downward atomic motion is concerned, there are infinite numbers of parallel and vertical lines\(^{143}\), each with the dimension of one *minima pars*, along which atoms follow whenever no external impacts force them sideways away from their tracks. However, if bodies are borne by their weights straight down through the void, then collisions and impacts among atoms would have never happened and this would entail that nature created nothing at all\(^ {144}\). This difficulty forces Epicurus to bring forth his much criticized "atomic swerve".

Epicurus did not mention atomic swerve in his extant writing but evidence elsewhere is overwhelmingly certain about its authorship being Epicurus. First, Lucretius did not mention his name as the innovator of atomic swerve but his *de Rerum Natura* should have been based on Epicurus' doctrines, particularly in this vital tenet. Second, disciples\(^ {145}\) and critics\(^ {146}\) showed great interest in this tenet and mentioned its authorship. It remains to be asked why should Epicurus not return to the position of Democritus who said that there was only

\(^{143}\) Sextus *A.M.* III.98: "straight line in the void".

\(^{144}\) Lucretius II.221-4; Cicero *Fat.* 21-22.

\(^{145}\) Philodemus *de Signis* 54; Diogenes of Oenoanda frag. 32.

\(^{146}\) Cicero *Fin.* 1.19, *Fat.* 18, 21, 22, 46 and 47, *ND* 69; Plutarch 964c & 1015c.
one kind of motion, i.e., blows? About this question, just like minimae partes, Aristotle's criticism was the catalyst for Epicurus to accommodate challenges and strengthen his philosophy while not losing the basic atomistic approach.

Democritean atoms are in constant motion in the void and eternally move from one place to another through the external impacts by other atoms. Aristotle criticized this theory and he pointed out three basic failures of it. (a) Atomic motion through external impacts is compulsory motion and compulsory motion is by definition posterior to natural motion and therefore there would not have any motion at all if there did not exist natural motion\(^\text{147}\). (b) The two cosmological principles or archai in the Pre-socratic atomist’s world are atoms and void, and atoms are of the same nature, and things of the same nature should move in the same direction and thus all atoms should move in the same direction\(^\text{148}\). (c) Void is infinite and without any mark of direction, but natural and compulsory motions have their own natural and alien places to move to, and thus atomistic void makes all motion impossible\(^\text{149}\). Furthermore, if void is a medium with no resistance to moving objects, then there is no reason why motion should be in this direction rather than in that one and why atoms should be in motion rather than at rest. This criticism is based on the "ou malton" principle\(^\text{150}\).

From what we know about Epicurus' response we may think that he took these criticisms seriously. His response to the distinction between natural and compulsory motion is his own distinction between motion due to weight and motion through external impacts. This meets the demands in (a). Epicurus defines this natural motion due to weight as an inherent quality of atom and as directional. This directional

\(^{147}\) Aristotle Phys. 215a1-5.

\(^{148}\) Aristotle De Caelo 275b30-276a6.

\(^{149}\) De Caelo 276a7-17; cf. Phys. 215a6-13.

\(^{150}\) Phys. 266b27-267a12.
motion implies that the void in which atoms move has a mark of direction, and Epicurus defines it in terms of personal viewpoints:

"... it is possible to assume one direction of motion, which we conceive as extending upwards ad infinitum, and another downwards... it is true that the whole of the motion in the respective case is conceived as extending in opposite directions ad infinitum"\textsuperscript{151}.

With this Epicurus could say that there are no other archai than atoms and void, and the other kind of motion by impacts is logically posterior. This still leaves the atomic swerve unaccounted for. Englert thinks that atomic swerve is a response to the distinction of motion into three kinds which Aristotle made in his Physics 225b30-1, and he has tried to link the random nature of atomic swerve with Aristotle's doctrine of accident\textsuperscript{152}. On this point my own judgement is that evidence at our disposal is flimsy and Englert's opinion is a result of his enthusiasm to connect everything Epicurean with an Aristotelian inspiration. The inner logic, which is to find a connection between those two motions, is a sufficient and necessary reason for the existence of atomic swerve\textsuperscript{153}.

What is this atomic swerve in its nature? Lucretius provided us with most of the information and in II. 243-50 it is reported:

"... the bodies must incline (inclinare) a little; but not more than the least possible (nec plus quam minimum) or

\textsuperscript{151} Ep. Hdt. 60.
\textsuperscript{152} Englert 57.
\textsuperscript{153} Lucretius II. 216-50; Fowler 1983:331. A doubt is cast on this assumed connection between sumbebekos and uncaused swerve by Sorabji in his Necessity, Cause and Blame (Duckworth, 1980) p.18. As for the question on the Aristotelian influence on Epicurean ethics I am a complete skeptic and agree with Sedley (Sedley 1983: 15, note 6) that this assumption would not only deprive Epicurean ethics much of its own import but also has to leave unexplained much evidence in Epicurean literature.
we shall seem to assume oblique movement (*motus obliquos*) and thus be refuted by the facts. For this we see to be manifest and plain that weight, as far as it in them lies, cannot travel obliquely when they drop straight from above, as far as one can perceive; but who is there who can perceive that they never swerve (*declinare*) so little from the straight undeviating course?"

This passage should be accompanied by II. 217-20:

"... the first bodies are being carried downwards by their own weight in a straight line through the void, at times quite uncertain and at places uncertain (*incerto tempore ferme incertisque locis spatio*) they swerve a little from the course (*depellere paulum*) just so much as you might call a change of motion (*momen mutatum)*."

And II. 259-60:

"... swerving our motions not at fixed time and fixed places (*declinamus item motus nec tempore certo nec regione loci certa*)?"

The first quoted passage (II.243-50) tells us that swerve as an atomic motion is an inference and cannot be counter-witnessed (*ouk antimarturesis*) by our experience because the least amount of space an atomic swerve covers provides no counter-witness for empirical falsification. It is another inherent quality of atoms but is logically posterior to natural motion. This does not mean that swerve only happens during the natural motion but in fact during all kinds of motions\(^\text{154}\). Another feature about atomic swerve is that it happens spontaneously and this injects an element of indeterminacy into the Epicurean universe and it

\(^{154}\) Engler 14-16.
has great implication for Epicurean ethics. The repeated efforts in our evidence to limit the range of spontaneity indicate a will to preserve the regularity and continuity of physical causation in nature\(^{155}\). Nevertheless, such an atomic swerve constitutes a disruption of the causal law and provides Epicurus with a plausible excuse for his denial of bivalence in any propositions, especially the future-tensed ones, since he seems, like Chrysippos, to believe that the logical necessity implied in propositions would entail physical causation\(^{156}\). Our present concern is to know what this atomic swerve amounts to in its range and how it behaves.

It seems certain that the range of atomic swerve at one time is one *minima pars* of space 'sideways' from the original track. These following pieces of evidence should be enough to confirm it: "*nec plus quam minimum*" in Lucretius II. 243-4, "*perpaulum quo nihil posset fieri minus*" in Cicero's *Fin.* 119, "*intervallo minimo, id appellat elachiston*" in *Fat.* 22 and others similar in *ND* 169 and *Fat.* 46-47; "*epitoulachiston*" in Plutarch 964 c and 1015 c; "*tas ep' elachiston parenkliseis ton atomon*" in Philodemus' *de Signis* 54 and Plotinus' *Enneads* 3.1.1. I have to emphasize 'sideways' because this is not a change of angle in the atomic motion as most of the Greek and Latin terms of swerve seem to suggest etymologically\(^{157}\), but a jerk and disappearance from the original track but 'then' a reemergence in the neighboring one\(^{158}\). As for the frequency of swerve I do not think that there is enough evidence for one to say anything exactly except its unpredictability.

From these pieces of evidence it can be assumed that the existence of atomic swerve presupposes the existence of *minimae partes*\(^{159}\).

156 Cicero *Fat.* 21 & 37, but cf. the more cautious *Acad.* 2.97; Sedley 1983:44-6, Englert 133, Long & Sedley 1987 vol. 1: 111-2.
157 Englert 18.
and all the uses of *minima pars* or its equivalents such as *minimum* and *elachiston* seem to suggest that these terms represent something constant in Epicurean universe\(^{160}\). The track along which atoms travel is of the dimension of one *minima pars*; atoms are composed of *minimae partes* and their sizes and shapes are decided by their numbers and arrangements; the speed all atoms travel at is one *minima pars* of space per *minima pars* of time; the spontaneous swerve is at one *minima pars* of space sideways at a time. These convince me that the concept of *minimae partes* is an integral and vital part of Epicurean physics.

Armed with the establishment of *minimae partes* as constants in the Epicurean physics I wish now to make a brief excursion into the mathematical dispute Epicureans had with those Euclideans who believe in the infinite bisection of a line\(^ {161}\). After his examination of *minimae partes* Vlastos reaches the conclusion that this concept was propounded as a law of nature: "Atoms are so constituted that variations in atomic lengths occur only in integral multiple of the smallest atomic length." This "smallest atomic length" is presumably *minima pars* of space, but 'length' is one-dimensional while from what I might have suggested that *minima pars* either in matter or in length is in fact three-dimensional. (I cannot imagine what a *minima pars* of time would "look like".) This basic unit as a measure of all bodies in the Epicurean universe is bound to change one's perception of geometrical entities in general.

What information we have about this new version of geometry is scattered and difficult to assess confidently but the "chains of circumstantial evidence are sometimes stronger than their weak links" and it seems possible that from the time of Epicurus the falsity of Euclidean geometry was an accepted Epicurean doctrine\(^ {162}\). Cicero's *Acad.* 2.106 and *Fin.* 1.20 are witnesses to the disastrous effect on mathemat-

\(^{161}\) Proclus 279.
\(^{162}\) Mau 1973:427.
ics this novel Epicurean approach had brought forth in the view of a hostile critic. Epicurus was said to have written a work *On the Angle* in the Atom\textsuperscript{163} while Sextus in *A.M.* III 100 mentioned:

"they say the angle is the minimum under the inclination (*hypo ten klisin elachiston*) of two lines which do not lie parallel, they mean by minimum either the indivisible body (*to ameres soma*) or what they call the sign and point."

These two pieces of evidence are suspiciously connected especially if the "either...or" in the second evidence is interpreted disjunctively as two versions of basic geometrical principle, i.e., an Epicurean one and an Euclidean one; the choice of vocabulary is certainly Epicurean. Sextus' *A.M.* III 98 also mentioned that the Epicurean straight line in the void does not revolve and this sounds an Epicurean snipe at some particular definition of line; Mueller explains that this Epicurean line is "imagined to connect two points or partless *minima* separated by the void"\textsuperscript{164}. According to Sedley in the extant mathematical works of Demetrius of Laconia the word 'elachiston' appears most frequently; earlier Philonides was said in the fragments of his biography "to have solved many geometrical [difficulties] concerning the elachiston"\textsuperscript{165}. From these pieces of evidence it seems not too far-fetched to suppose that *minima pars* also plays the role of constant in Epicurean version of geometry as it does in his version of physics.

For more extended documents about Epicurean mathematics at work I shall now turn to Proclus and only give a brief opinion of my own on it, which I think will strengthen my argument conducted so far.

\textsuperscript{162} Mueller 1982:95.
\textsuperscript{163} *D.L.* X.28.
\textsuperscript{164} Mueller 1982:73, note 6.
\textsuperscript{165} Sedley 1976:24.
Proclus in 199-200 categorized three groups of critics of Euclidean geometry:

(A) Those who were positively hostile to geometry, and this category included two groups:

(A.1) the skeptics who were prepared to do away with all philosophical knowledge, and
(A.2) others like Epicureans who shared skeptics' distrust of geometry but were nevertheless dogmatic in other areas.

(B) This group of critics, which included Zeno of Sidon, admitted the principles of geometry but denied their completeness and therefore was suspicious of all the propositions inferred from them. Its intention was supposed to strengthen, not to overthrow, geometry.

I shall discuss (B) group first.

In Proclus 214-5 Proclus reported that Zeno of Elea raised objection to the construction of equilateral triangle unless we are allowed that "two straight lines cannot have a common segment." The same objection was applied to 215-6, concerned with the segment which the circumferences of a bisected circle might share. Luria and Sedley detect the theory of *minimae partes* at work here. Let's suppose that the lines and circumferences are all of one *minima pars* in dimension, then two intersecting lines or circumferences would have a common segment of one *minima pars*. Proclus, when he spoke of Zeno's objection, seemed very willing to concede with grace to Zeno's charge, and indeed he would have welcome to add "two straight lines cannot have common segment" in his definition since Zeno's caveat

166 Sedley 1976:25.
was Euclidean in spirit. However, when Zeno made this caveat, does he mean that he had already accepted some principles, if not all, of Euclidean geometry? This caveat, I suspect, might well have been intended as an attack, particularly when we happen to know that Zeno was credited with a work "peri parenkliseos" which is intrinsically connected with minima partes. I suspect either that Proclus' victory was cheap or that Proclus separated Zeno apart for no better reason than a desire for categorization.

This could be seen in Proclus' distinction of the (A) into (A1) and (A2). So far as geometry is concerned, skeptics and Epicureans were on the same front and the fact that skeptics suspended all knowledge simply had nothing to do with the present purpose of which Proclus was in pursuit. On the other hand, skeptics could have deployed all the Epicurean gears to blast geometry as our examination of Sextus' A.M. III 98 & 100 has shown. When we turn to other parts of A.M. III we find that most of Sextus' weapons were, indeed, suspiciously Epicurean if only in a less systematical and sometimes more whimsical way. Take an example of his ridicule of incorporeal line, which is repeated ad nauseum throughout A.M. III. Sextus had always born in his mind that line was corporeal and even was constituted by corporeal points\(^{167}\) though he did not mention these points being minima partes. This less than honest practice is understandable for the motivation of a skeptic. Mueller in his extended survey of A.M. III reaches the conclusion that Sextus had provided a basis by which Epicurus could deny the intellectual respectability of geometry\(^{168}\) but the story should be that the Epicurean theory of minima partes provided the basis on which Sextus could suspend geometrical knowledge. Again, after his examination of the relational consideration of geometry (i.e. n-dimen-

\(^{167}\) Sextus A.M. III.109ff.  
\(^{168}\) Mueller 1982:79.
sional geometrical objects are composed of (n-1)-dimensional geometrical objects) from the implied presuppositions used by Sextus on limit, composition and contact, Mueller says that the line of Sextus' attack was a "dogmatic 'empiricist anti-geometry'" in which every geometrical objects were extended in three dimensions\(^{169}\), and I have said that minima pars is a three dimensional constant. This argument is closely connected with atomism, particularly with Ep. Hdt. 56-9 which is about minima pars\(^{170}\).

Such an examination of these documents persuades me that all the distinctions Proclus made in his categorization of critics are gratuitous and, even if any differences had ever existed among them, they were not so distinct as he wished us to believe. After my examination of these scattered documents together with A.M. III it is my opinion that both (A) and (B) share the same basic belief in minima pars and therefore this concept prompted Epicureans to adopt a new approach to geometry for which Cicero greatly lamented.

A brief summary of this application of minima pars in Epicurean physics and mathematics. The concept of minima pars as physical phenomena is said to provide the physical constant in the Epicurean universe and, from our examination, we have proved that this concept could be integrated as an intrinsic part of Epicurean physics. These two facts tend to enhance the order and regularity of Epicurean universe and the promise of atomistic and scientific approach toward its analysis. On the other hand, we have seen that atomic swerve, which must presuppose minima pars for its existence, is said to inject an element of indeterminacy into this universe and, ironically, this universe (which is subject to scientific analysis) is said to be impossible without this swerve. We seem to be at a dilemma

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170 Mueller 1982:89.
— the *minimae partes* are constant in the Epicurean universe but are also related to indeterminancy - and I am not sure if it is the mistake of my inquiry or the basic inconsistency that is inherent in this concept that creates this paradox. We shall meet the same dilemma again in the next section of exposition.

In my excursion into mathematics I have tried to examine different sources of evidence to prove that there did exist a tendency among the Epicurus and successors to "physicalize" mathematics and the basic tenet in their crusade against Euclidean geometry is the concept of *minimae partes*. This brief discussion should suffice for my present purpose.

**IV. 2. Application of Minimae Partes in Epicurean Ethics**

In my discussion on the application of *minimae partes* in Epicurean physics I have tried to envisage atomic and sub-atomic motions; in this part of exposition our attention will be shifted to the association of *minimae partes* with the higher order of existents, especially human behaviors as expressions of free will\(^{171}\). This interest is partly determined by the nature of extant materials at our disposal. To make a comprehensive examination of this rather complicated question is beyond the scope of this essay and therefore efforts will be devoted alone to the question of how Epicureans relate the sub-atomic phenomenon - that is, the atomic swerve - to the moral behaviors as expressions of free will. Accordingly, I shall present the following inquiry in a more schematic way than our sources would allow because

\(^{171}\) It is not certain if the talk of free-will problem is anachronistic in ancient literature. Since my concern is about *minimae partes* in this place rather than a full discussion on this thorny question, I therefore beg for a linguistic license in this inquiry. Please see Conway 81-2.
I believe this will be a better way in focusing on our concern.

I shall differentiate two approaches to this question into a reductionist\textsuperscript{172} approach and an anti-reductionist approach, both of which have very different views on what a role the atomic swerve should play in Epicurean ethics and how intimately the atomic swerve and free will should be related to each other. I shall start from the reductionist approach and quote a statement from Engler which illuminates its basic position rather accurately: "If there was an irreducible difference between the motion of animate and (sic. that of) inanimate bodies, it had to be explained on the atomic level"\textsuperscript{173}. This reductionist tendency to identify the macrocosmos with microcosmos or to eliminate the former in favor of the latter also dictates the choice of materials on which the reductionists base their interpretation\textsuperscript{174}.

There are more than one kind of determinism Epicurus wished to escape from. He expelled gods from his picture of the world and thus dismantled theological determinism\textsuperscript{175}. There is also logical determinism, a thesis that the future will be the same as the past:

"... Epicurus is afraid that if he admits this [i.e. every proposition either being true or false] he will have to admit that all events happen through fate"\textsuperscript{176}.

This denial of propositional bivalence seems an overreaction but receives some revision in \textit{Acad.} 297:

"... I admit that one or the other is necessary, it will be

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\textsuperscript{172} A definition of reductionism could be found in Wardy 1988a:112 where it is defined as: "'reductionism' can serve as a label for the thesis that events falling within a given, more or less strictly defined, class are to be explained exclusively in terms drawn from a distinct and more fundamental class." Cf. Sedley 1983:33 and 1989:297-302.

\textsuperscript{173} Engler 54 & 126.

\textsuperscript{174} Engler 142-3, Saunders 39; cf. Sedley 1983:11-51.

\textsuperscript{175} Diogenes Oenoanda frag. 32.

\textsuperscript{176} Cicero \textit{Fat.} 21 & 37.
necessary either for Hermarchus to be alive tomorrow or for him not to be alive. But there is no such necessity in the nature of things."

The logical necessity in a proposition does not entail causal necessity in nature and is thus rendered harmless. However, it seems most urgent to escape the grip of physical causation when we come to the question of free will since atomisitic analysis occupies such a prominence in Epicurean philosophy, and the mind, from which actions are said to be initiated, is corporeal and potentially subject to the same atomistic analysis. In short, the Epicurean world-picture is both non-providential and yet deterministic. Cicero reports that Epicurus invented the atomic swerve, which occurs without a cause and at no certain place and time, in order to avoid the necessity of fate and his fear is apparently of what might have been implied in his physics for his free will. Our sources suggest that he means to rectify a mistake committed by Democritus and his lesser successors. However an elaboration of this relation between physics and ethics - atomic swerve and free will in specific - has to rely on an analysis of the important passage from Lucretius II. 251-93.

This passage could be roughly divided into three sections: (1) 251-62, (2) 263-87 and (3) 288-93. What I shall do in the following is to give a gist of these three sections, but we have to remind ourselves, first of all, that the passage 251-93 is embedded in an extended inquiry into Epicurean physics and its appearance there seems, prima facie, rather out of context, but the significance of its appearance in that place will be considered later.

178 Cicero Fat. 22.
(1) 251-62 consists of two arguments for the existence of atomic swerve. The first one is from 251-55, which continues the cosmological argument of 216-50, and is presented as transitional stage from the "physical argument" to the "ethical argument" of 256-60, which is presented as a typical Epicurean sign-inference:

"... if the first beginning (primordia) do not make by swerving (declinado) a beginning of motion (motus principium quoddam) such as to break the decree of fate (fatis foedera) ... whence comes this free will (libera) in living creatures all over the earth, whence I say is this will wrested from the fate (fatis avolsa voluntas)...?"

Our exertion of libera voluntas in this case is the 'sign' and from it we 'infer' the existence of atomic swerve. Moreover, this argument also gives us some information about the capacity of voluntas to initiate movement, a view that is typically Greek in seeing soul as a kind of autokinetic force. This seems to be confirmed by the fact that "motus principium quoddam" is related to 'declinado' while in the unquoted 259-60 we are told it is through 'voluntas' that we 'declinamus' at uncertain time and place. 261-2 summarizes this capacity of initiation of movement in us:

"... it is his own will in each that begins these things (his rebus sua cuique voluntas principium dat)."

251-62 thus constitutes an attempt to connect the atomic swerve with our capacity to initiate movement. How this linkage functions is to be illustrated by two examples in (2). In (2) the examples of racing horse (263-71) and pushed man (274-83) are susceptible to more than one interpretation but for our present purpose I shall lay emphasis on the time gap between the stimuli of external simulacra and the responses to them. As the responses in both cases are not immediate
(II. 264-5), this shows that something else must be involved, and either it is the exercise of intelligence and thereafter follows the beginning of motion \(\textit{initium motus}\) "\textit{ex animique voluntate}" (II. 270) or the "\textit{arbitrium}" of something in our mind which compels the mass of matter to be turned through body and limbs (II. 279-82). In fact, no atomic swerve is mentioned here, but the "\textit{initium motus}" is suggestive of (1). The summary of the moral lessons of these examples in 284-7 repeats the point already made in 256-62, and a natural reading of these two examples is to put them in this context:

"Therefore you must admit that the same exists in the seeds (\textit{seminibus, = atoms?}) also, that motions have some cause other than blows and weight, from which this power is born in us".

Atomic swerve apparently lurks behind the operation of free will in these two examples. Moreover, "from which this power is born in us" establishes again the close connection between the micro-cosmos and macro-cosmos.

(3) The section from 288-293 is very ambiguous in meaning and different interpretations of it are possible. It is read:

"For it is weight that prevents all things from being caused through blows by a sort of external force (\textit{enim prohibit ne plagis omnia fiant externa quasi vi}); but what keeps the mind itself (\textit{mens ipsa}) from having necessity within it in all actions, and from being as it were mastered and forced to endure and suffer, is the innate swerving of the first beginnings (\textit{id facit exiguum clina-men principiorum}) at no fixed place and no fixed time".

This passage seems to consist of two sub-arguments: one is against the chance due to external blows and this echoes Epicurus' criticism of
Democritus; the other is against the necessity which atoms with weight but no swerve would produce, and this sounds a retraction of Epicurus’ original doctrine after Aristotle’s criticism. It is not clear whether the referent of external force (289) and that of inner necessity (290) are the same. Furley thinks they both refer to mind (mens) and understand this passage in the way that "weight is sufficient to save the mind from the external force of collisions, but the swerve saves the mind from the constraint of an inner necessity"\textsuperscript{180}.

This reading makes atomic swerve a negative factor in its interruption of external and internal necessity but this is antithetical to the whole trend of thinking in 251-87, which is to bestow on atomic swerve a positive capacity of initiation in movement. What could be a more natural reading than that, when Lucretius said the atomic swerve kept necessity from mind, he meant this positive capacity?

Granted that a mind with atomic swerves is endowed with the capacity of initiating movement, one may well begin to ask how it works and how the random nature of swerve could be reconciled with the intentionality and rationality of our behavior? These two questions have to be put in the context of Lucretius IV. 877-91 where a description of walking mechanism is expounded. When one focuses on simulacra of walking and then his voluntas or desire of walking occurs, the mind is then constituted by a certain pattern of atomic arrangement. It is at this very moment that Englert sees the intervention of atomic swerve. This is a very hypothetical reconstruction because IV. 877-91 has never mentioned any swerve at all and Englert has to rummage through Aristotle’s Motus Animalium to find its resemblance — that is, sumphuton pneuma — to prove that the atomic swerve is really in IV. 877-91\textsuperscript{181}. This is very unlikely in my view. What is important for the

\textsuperscript{180} Furley 1967:182 but cf. Stokes 289 and Englert 72-3.
\textsuperscript{181} Englert 121-4.
present moment is that atomic swerve has to work within a context, presumably our character or mind/soul complex which undergoes some change as a result of the bombardment of *simulacra*. The random nature of atomic swerve guarantees that the responses to external *simulacra* are not immediate and reflexive but this still leaves unexplained the intentionality and rationality of our behaviors. The most one can say about the function of swerve in this case is that it probably constitutes a necessary condition of free will but certainly not a sufficient one. It is deprived of its supposedly positive contribution which we are led to expect from II.251-93. In fact, Englert, the most tenacious defender of the intimacy between swerve and free will, has to back down from this position and leaves swerve to take care of itself: "the disposition, or character, of the human or animal agent determines what form the reaction to external stimuli will take"\(^{182}\). A more limited claim for swerve in ethics, in my view, is in effect more consistent with the role that the atomic swerve plays in physics since both are then only necessary and disruptive forces in their respective areas which account for the formation of the universe and everything that came after it.

Therefore, this attempt to reduce free will to a function of the atomic swerve is a failure. Its basic failure consists in the great difficulty to satisfy and reconcile two requirements: (a) it must guarantee the random nature of atomic swerve in the microscopic world and (b) it must preserve intentionality and rationality in the interpretation of our behavior. Two possibilities are open to those who espouse the reductionist approach, either that (a) can be imposed on (b) but then the intentionality and rationality of human behavior is lost, or that (a) has no effect at all on (b) but then our behavior is strictly determined in the Epicurean economy. These two possibilities are presented as incom-

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\(^{182}\) Englert 127.
patible or disjunctive: if one is not an anarchist, then one is bound to be a determinist. This is not very attractive. This basic dilemma is thus built into the reductionist approach but the implied disjunction of anarchism and determinism is antithetical to the quest of free will which, Epicurus in *Ep. Men.* 134 insisted, did exist.

I have said that the reductionists have to rely on Lucretius II. 251-93 for their interpretation, to the neglect of other vital sources regarding this important question of free will. However, as II. 251-93 is placed in an extended discussion of Epicurean physics and its digressive nature should remind one of the possible distortion of perspective on this question. More drastically than this, Mitsis has suggested that Lucretius has rarely talked about ethics and, if his task is to understand atomic motion in Book II, he might have thought it superfluous to spend too much time on ethical explanation which can never pretend to be an explanatory economy, i.e., to proceed from the more simple to the more complex, or from bottom to top, such as the reduction of free will, as has just been expounded above, to the interaction of atoms and atomic swerves. On the other hand, when we turn to other sources of evidence regarding free will, especially those from Epicurus' *On Nature,* we find they have the clear tendency to separate the higher order of activity from atomic motion and even suggest a top-bottom interpretation of free will183.

The gist of this anti-reductionist approach is to recognize the moral autonomy of human agent. Because in this approach the role of atomic swerve would become negligible, my exposition will therefore be brief. At the end of it I shall try to rationalize the introduction of atomic swerve in the free will problem.

In *Ep. Men.* 133-4 Epicurus categorizes things into three kinds, either they are necessitated, or are due to chance, or are dependent on

us (par' hemin). It is with those things dependent on us that culpability and its opposite are associated. This use of apportionment of blame and praise as a sign of moral responsibility and free will is typical of Epicurus and appears repeatedly throughout *On Nature*. This emphasis on moral autonomy goes with a denial of atoms as a factor in moral development:

"Many naturally capable of achieving these and those results fail to achieve them because of themselves, not because of one and the same responsibility of the atoms and of themselves... The nature of their atoms has contributed nothing to some of their behavior, and degrees of behavior and character, but it is their developments which themselves possess all and most of the responsibility for certain things... Thus when a development occurs which takes on some distinctness from the atoms in a differential way - not in the way which is like viewing from a distance - he acquires responsibility which proceeds from himself"\textsuperscript{184}.

This passage shows that Epicurus has in his mind a distinction between two kinds of relationship which atoms obtain in relation to "their developments" (*aata ta apogegevmena*). On the one hand, Epicurus recognizes the etiological reductionism which an atomist could claim for the composition of simples into a complex; on the other hand, he carefully points out that the *apogegevmena* (and, more extensively, all phenomenal entities) enjoy the same ontological privilege as atoms do (otherwise the Epicurean thesis that all sensations are true would not be valid) and this fact precludes the reduction of the former to the latter\textsuperscript{185}. In terms of our present topic we may say

\textsuperscript{184} Epicurus *On Nature* 34.21-2.
that *libera voluntas* and its expressions, although they are accidental properties (*sumptomata*) of the mind, "are seen to be exactly as and what sensation itself makes them individually claim to be."\(^{186}\). This amounts to a recognition of a gap separating the macro-cosmos or a higher order of existents from the micro-cosmos or atomic world.

Carneades, according to Cicero, thinks the "fictitious swerve" is unnecessary if Epicurus has already taught that a certain voluntary motion of the mind was possible and "this voluntary motion itself has it as its own intrinsic nature that it should be in our power to obey us."\(^{187}\) A recognition of this gap is one thing but whether it is possible to surmount this gap is another. Epicurus continued the passage we quoted from *On Nature*:

"... he straightaway transmits this to his primary substances (*proton pheuseon*) and makes the whole of it into a yardstick (*kanona,*"

This seems a top-bottom model of interpretation and means "psychological causation actually operates on our components atoms."\(^{187}\) The yardstick in question indicates a pattern of atomic motion after being molded by our *apogegelemena* and it will regulate our future behavior.\(^{188}\)

This top-bottom and anti-reductionism interpretation has the merit of rescuing us from being as hopeless spectators of our behavioral mechanism dictated by physical laws. Yet, what kind of role could the atomic swerve play in this picture? Sedley says that a mere possibility of its occurrence, injecting an element of absolute chance in the pre-determined grooves along which our mind's atoms follow, would be a

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188 Sedley 1983:39.
189 Sedley 1983:41.
most economical realization of free will. This explanation still does not answer Carneades' criticism satisfactorily because if moral autonomy can assert itself, then indeterminacy brought by swerve remains superfluous. In addition, even if the indeterminacy implied in the atomic swerve could bring us 'freedom,' then it is very clear that this 'freedom' is highly revised in its meaning, tenuously related to our ordinary use of this word. One step further beyond Sedley's suggestion is apparently necessary.

A possible solution, if I understand Mitsis correctly, is to recognize the incomplete account of the "emergent properties" which combinations of atoms produce in Epicurus' work. First of all, the conjuration of our moral intentions as autonomous agents out of lifeless atoms remains mysterious but Epicurus seems to take this for granted in his On Nature. It is therefore possible to assume a causation between macro-cosmos and micro-cosmos though whether this assumption of a causation could be found and tested is unknown. The supposition of atomic swerve precludes an informative explanation at the microscopic level of nature and accordingly presents a permanent barrier to any causation and, therefore, reductionism. In this way, atomic swerve remains after all a physical phenomenon and its exclusion, among other possibilities, from the extant works of Epicurus is understandable but its intrusion in Book II. of De Rerum Natura constitutes an unwarranted excursion.

A summary of this part. My discussion on the role of minima partes, in the form of atomic swerves, in the free will problem has not only the ethical question in view but also the explanatory force of minima partes in the higher order of existents. The reductionist approach is to adopt a positive connection between micro-constituents and macro-

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190 Mitsis 164-6.
conglomerates but this is impossible because there is probably built into the concept of *minimae partes* two contradictory elements, i.e., *minimae partes* as constants and measures and atomic swerves as the disruptive and indeterminate factors in the universe. This inherent conflict has been pointed out in my exposition in the part of physics. The reductionists attempt to rewrite the scenario of free will in the same physical language without conjuring away such a contradiction and thus fall into the incompatible dilemma of determinism and anarchism. This is a price to be paid for the desire for explanatory economy, which is often a temptation too great to resist. The anti-reductionists, on the other hand, separate these two areas and liberate moral autonomy from atomistic analysis and from the incompatibility mentioned above. This could mean that Epicureans have to start from scratch a phenomenology of free will and Epicureans, in fact, have already had a good start on account of their robust trust in phenomena and in their ontological authenticity. The introduction of atomic swerve into free will problem strengthens the independent value of this moral inquiry because its indeterminacy somehow paralyzes physics and physics thus has to leave free will problem alone.
V. A Tentative Conclusion

From this examination of the application of *minimae partes* in Epicurean philosophy we can now realize what a deficiency of our understanding would be if we did not start our research from a historical survey of the genesis and evolution of *minimae partes*. Zeno of Elea's paradoxes have had different implications for different philosophers; the different approaches they adopted are not only answers to solve the puzzles but often imply different Weltanschauungs. Ancient atomism is certainly one of the most imaginative approaches that have been developed. The Epicurean version of atomic approach is to see the world full of chance, necessity and *par' hemin*\(^{191}\), and it is the conceptual creation of *minimae partes* which makes this kind of world possible. *Minimae partes* are measures and constants of this universe and thus make the whole nature liable to an atomic analysis and subject to the regulation of physical laws. *Minimae partes*, on the other hand, also make possible atomic swerves, which upsets the whole picture of ordered universe and creates chances and uncertainties. Lucretius in his *De Rerum Natura* II. 251-93 tried to find, in the form of atomic swerves, a way out of this incompatible dilemma and allocated an initiative role of rationality and intentionality to *minimae partes* with the unpredictable swerve and thus a place for *par' hemin*. This concept of *minimae partes* is certainly versatile! Perhaps, too much so. It embodies all the possibilities in the Epicurean universe.

Sambursky, however, laments its creation and thinks Epicurus should have been satisfied with the teachings of his Pre-socratic predecessors.:

"Lucretius gives up the Democritean necessity and revokes the general application of the law of causality as

it had been established by Epicurus’ predecessors.192

Cosmogny is something unscientific and the creation of atomic swerve serves simply this purpose.193 Although what has been wrong with minimae partes and atomic swerves might have something to do with deficiency of this cosmological story, Sambursky’s judgment remains somehow uncharitable, so I think, because atom for Epicurus is not only being but also material and origin, a product of Pre-socratic arche and Aristotelian hule, endowed with efficient cause for the creation of worlds.194 If there is any missing link in this cosmogony, a supposition of atomic swerve is not a crime. The inner force of logic is a rationale enough to legitimize this physical concept. Another critic - Sedley - of this introduction of atomic swerve shares with Sambursky’s lack of interest in cosmogony but suggests instead that it was his work on psychology that led Epicurus to this innovation.195 Apart from the very difficulty of source problem, this negates the physical and mathematical history of atomic swerves we expounded in IV. A. and thus indirectly denies minimae partes. It also impeaches Lucretius’ authority on Epicurean physics which is much more secure than his opinion on ethics.

It is therefore my judgement that minimae partes and atomic swerves are fundamentally physical phenomena and their intrusions into ethics are a desire for explanatory economy and a strategy of reductionism. The failure of reductionism is the failure of the concept of minimae partes because this concept harbors an insolvable conflict. Perhaps the greatest mistake of Epicurus with regard to this concept is

194 Solmsen 274.
that he wished it to do too many things in his natural philosophy; his less talented disciple Lucretius made it do anything possible and impossible. For these atomists, however, it seems that the potency of minimae partes is the potency of atomism in general.
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