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107-499D: Thesis

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Why Atomism?

This paper contains several parts. The first will be a brief discussion of why I find the atomism issue in the history of science still topical and not only a historical curiosity. The second part will survey the contemporary literature on the subject, including that of Pullman (1998), Lewis (1998), Berryman (1999), Sorabji (1983), Furley (1967, 1987), Makin (1993) and Hankinson (1998). The third section will look at other ancient thinkers and relate Leucippus and Democritus to them, particularly to Parmenides and Zeno. In the fourth part I will attempt to put together a coherent picture, drawing upon the insights of contemporary commentators as well as some points of my own on certain overlooked issues. Furthermore I will draw a conclusion about our state of knowledge in these matters. The fifth section will move slightly away from the history of philosophy and science perspective and briefly into the more directly philosophical in order to draw three contemporary lessons.

A brief remark on language issues. Since I do not read ancient Greek, for Greek words I use, such as ajdiaivreton and a[toma, I simply relying on translations by Eric Lewis' (private communication) or those of the authors given. Since part of the bone of contention revolves around translation issues, I am will attampt to read each potentially contentious passage in various ways in order to check both the heterodox position and the orthodox one. I shall generally simply use "ajdiaivreton" in the midst of my English where the word is needed but I do not intend to commit to either meaning of it. We shall see that it is likely that both positions have some grains of truth; this will suggest that perhaps Aristotle or the other surving ancient sources of the atomic accounts are confused, (or of course that Leucippus or Democritus were.)

Also note that I regard Leucippus and Democritus' views as being identical (I will generally refer to them collectively as "the atomists" throughout this paper, as it is about presocratic atomism). While this is very historically implausible, I feel there is insufficient material extant to decide in what respects the two differed. I regard both men as the joint originators of the hypothesis of atomism, at least in ancient Greece. I draw attention to the latter, as there is an interesting passage (in Kirk, Raven and Schofield 1992 [hereafter: K,R,S], §544) which suggests a possibility (very tiny) that Democritus was influenced by Indian atomists. (It is known that atomism was also invented in India at approximately the same time as it was in Greece):

> "Some say that he associated with the 'naked philosophers' in India; also that he went to Aethiopia."

As I do not know enough about the history of natural philosophy in India to pursue this line of investigation further, I will ignore this possible influence in the rest of the paper and concentrate on Greek influences and motivations. (This suggestion is not meant not to rule out its reverse - Democritus may well have influenced the Indian natural philosophers, or the influence could well have been mutual.)

Section I

As stated in the introduction, this paper consists of a discussion of a very old issue in natural philosophy. For this reason, I have included a twofold explanation of why this topic goes beyond an historical interest and fits into a broader picture in my work. First, a strictly personal one, is that I feel my exact reasons for working on this problem should be made explicit as they infect the second point. Second, I feel that ancient science does still have a few lessons to teach contemporary philosophers of science - I will state these lessons briefly here, as I do not wish to dwell on them that much.

On to my reasons, then. I have two personal reasons for this work, the scholarly and the curious. The scholarly reasons for working on ancient atomism are twofold. One is simply to explore an important and controversial issue in the history of natural philosophy. The second is to lay the groundwork for future work in contemporary philosophy of science, drawing upon the lessons of the past where possible and necessary. The curiosity reason is simply that I find the issue altogether fascinating and not completely explored as yet.

As for what ancient atomism can teach contemporary philosophers of science, I think there are at least three lessons. One is primarily didactic - to encourage scientists to use as clear and precise a language as possible, perhaps even helping them by acting as “concept sharpeners”. The second point is one of continuity in the meanings of terms. At least two books (Pullman 1998; Melsen 1952) have been written on the history of the atomic concept. We shall meet some of their interpretations of Leucippus and Democritus in due course. However, my point here is that we now have the correct formal tools to check reference and extension of concepts. Therefore we can use them to minimize confusions over language and choice of words.

Section II

Section II is further subdivided, consisting of responses to various recent work on ancient atomism. Each subsection will be partially expository and partially critical and can be read somewhat independently of the others. This section is something of a (modern) literature survey on the subject.

Does Aristotle’s Disproof of Atomism in the *Physics* Rely on the Apparent Absurdity of Atomic Space & Time? An argument against Lewis (1998)

In this subsection I will discuss Aristotle’s ‘refutation’ of atomism in the *Physics* and relate it to a new view on the atomists held by Lewis (1998).

On one possible reading, it may appear that Aristotle's disproof of atomism in the *Physics* relies on a reductio involving atomic space and time. This subsection discusses why this reading is incorrect, and uses this issue as a sounding board for arguments for or against a recent paper by Lewis (1998). Aristotle makes it clear in Chapter 6 of Book III that he thinks that every extended magnitude contains a potential infinity, as it is capable of being divided indefinitely (see lines 206b3-206b12). Aristotle is also committed to the idea that anything indivisible is something which has no parts. (Therefore, if he thinks that the atoms were indivisible he will run into conflict with the atomists if anything can show the atoms to have parts - but we know they were said to have hooks and barbs and so on, suggesting parts.) Chapter 1 of Book VI of the *Physics* (Aristotle 1996) contains Aristotle's reasons for which a continuum cannot be composed of indivisible parts. Now, if the atomists argued for <u>undivided</u> atoms, they can surely agree with this. So far no disagreement. But in chapter 2, we find more of Aristotle's reasons for <u>space and time</u> being continuous. First, he reminds us that by continuum he means that which is divisible into parts which are further divisible. This also the atomists can potentially agree with if the atoms are undivided (there is a potential problem with Lewis' interpretation here which I will return to in due course). Aristotle then gives his solution to one of the Zenonian paradoxes. All the accounts of motion seem to require continuous motion. Nowhere does Aristotle explicitly mention this, however, he probably takes it for granted, as there is no recognition of the alternative(s?). If we read Book V, chapter 4, here we find that Aristotle thinks that all change is continuous. So if motion is a kind of change, it is therefore continuous. We have hence located a possible root source of disagreement between him and the Atomists.

Now we must see whether Aristotle thinks that the atomic account commits one to thinking that motion is discrete. If we think that the atomists are responding to Zeno, we note that the Zenonian argument applies to any magnitude. So, assuming Zeno's argument to be valid, whether or not a[toma,

ajdiaivreton and its cognates have meanings related to undivided or indivisible, there simply must be atomic times and spaces on the atomic conceptions, unless time and space are themselves not magnitudes. Here the indivisibility interpretation (of a[toma/ajdiaivreton) falls flat on its face. I see no evidence to suppose that the atomists postulated indivisible space and time. But they surely hypothesized undivided space and time. For instance, if one has an atom at point a below, and another at point b, then the spatial interval is undivided. Then, as in the second figure, another atom, c, wanders in, then ab is divided by c. (Note then that the spatial intervals ac and ab become atomic in this sense.) Lewis' interpretation saves the day, and doesn't require the atomists either to postulate "strangely atomic" spacetime (that is, space and time as indivisible), or the like. (One shouldn't get one's hopes up too soon, though, as there are problems with this suggestion.)

a_____b
Figure 1

a_____c_____b
Figure 2

Since the atomists are not obviously (i.e. non controversially) committed to atomic space time in the usual sense, Aristotle's arguments against them in this area don't get off the ground, reductio or otherwise. This raises the question on how Aristotle understood a[toma and the related words. If he understood them to mean indivisible, the arguments do go through, as the criticisms do involve "conceptual" division by things passing in front of other things and so on. But then we are in the unfortunate circumstance of saying that Aristotle didn't understand what the atomists were getting at, at least in the Physics, assuming that the atomists meant undivided by ajdiaivreton (and hence "not cut" or something similar by a[toma) etc.

On the other hand, Aristotle's arguments are bad arguments if

ajdiaivreton and related words have as connotation undivided. We can see this by simply noting that something undivided would mean just any magnitude bounded by void or another object. What else could divide it? If ("macroscopic") objects for the atomists exist by convention, then it would seem that void would have to do the dividing. Hence all of Aristotle's argument against atomism in the *Physics* must rely on his critique of void, which I will take up at another time. (See section IIIe for this issue.) I note that Aristotle doesn't EXPLICITLY talk about the atomists in Book VI, and is only taken to be arguing against the atomists and for continuity. But as we have seen, there is a way in which the atomists are for continuity, if "a[toma" is taken to involve the property of "undividedness". This raises the question of who Aristotle could be arguing against (if anyone at all) in this section if not the atomists. Some have taken Plato to be Aristotle's target here. See Makin 1993 and section IId below. (This is a problem for whomever wants to agree with Lewis.)

There are several other direct problems with Lewis' account, however. Firstly, fragment 579 in *Presocratic Philosophers* (Kirk, Raven, Schofield 1995) reads rather strangely if you replace undivided with indivisible at least in the English (I make no claims about how it reads in the Greek, of course).

> "For they [sc. Leucippus and Democritus] say that their primary magnitudes are infinite in number and undivided (after Lewis) in magnitude; the many does not come from one nor the one from many, but rather all things are generated by the intertwining and scattering around of these primary magnitudes."

Note that there is a bit of a semantic issue in the passage. I am not claiming that the sentence is grammatically strange (though it is), I am claiming instead that following Lewis' suggestion here makes the meaning of this sentence very confused, where as the orthodox translation is a bit more straightforward. What would it gain to point out that here are things which are undivided? On one way of reading that claim, it is almost a truism: how

could there be magnitudes which are divided? If they are (completely) divided, they wouldn't be magnitudes, but nothing at all.

Furthermore, there is another problem with assuming that the atomists allowed continua composed out of undivided magnitudes. Consider again Figure 1, above, but this time interpret the figure to mean that a and b are the "ends" of a continuum of atoms. I do not see any way to interpret this as more than one atom, as the whole continuum is undivided. There is no sufficient reason for it to be divided here rather than over there. If we reject the principle of sufficient reason (or the *ou mallon* version of it, for which see Makin 1993 and my commentary below in section IId), then we possibly get into Parmenides' trap which the atomists are presumably trying to avoid. This argument depends on the atoms being homogeneous in some sense. (If they weren't, then this argument fails to go through.) So in order to have any sort of divisibility, the atoms must not be homogeneous. Are they? Well, they are said to have hooks, and barbs, etc. which makes them heterogeneous in one sense. But they are also all composed out of the same sort of "stuff" which makes them homogeneous in another sense. I do not see a way to decide this issue at the present time. There is a curious line that suggests the heterogeneity caused by the hooks and barbs does allows a real distinction amongst the atoms. "They struggle and move in the void <u>because of the dissimilarities between them</u> ..." (§578 K,R,S) In that passage, there is the suggestion that the atomic dissimilarities do cause motion, and hence there is sufficient reason for this to "be" an atom and <u>that</u> to "be" an atom, and therefore for one to be able to overcome the "one big atom" problem above. But this relies on a probably overly pedantic reading (in translation, as well) of one passage in a lost work. I therefore wouldn't rely on it to solve the above problem. Note, though, that if the atoms are already divid<u>ed</u> this problem is nonexistent, as is if the atoms are indivisible, because then they can just "break apart" wherever they "end". See below (figure 3). If ae is taken as one body consisting of atoms ab, cd, ef and gh and atoms are indivisible, then if ae breaks apart, it can "decompose" into the atoms ab, cd, ef, gh. Or it can

break at c, leaving the atom ab and the compound of cd, ef and gh. Note the grave problems of identifying the atoms if they are taken to be undivided and in complete contact. How does one “tell them apart”?

a____bc____de_____fg_____h
Figure 3

Another passage which seems to spell trouble for Lewis’ view is in *On Generation and Corruption* (Aristotle 1982, hereafter GC). Aristotle writes (316b32):

> “It must therefore contain atoms possessed of size, which are invisble; not least if coming to be and ceasing to be are to take place by aggregation and segregation respectively.”

If Lewis thinks Democritean atoms were things that were undivided, this passage seems to provoke a question about this account. On the orthodox viewpoint, only atoms would be indivisible. We must now ask if atoms are to be the only things which are undivided in the Lewis account. If atoms are that-which-are-undivided, then the above seems to commit one to having the atomists as saying that anything visible is <u>divided</u>, by modus tollens.

There is of course a way out of this problem - namely, that atoms are only some of the things which are undivided. On this view special undivided things were the atoms, and mundane undivided things were undivided bricks, tables and Zeno’s toe. Then one has to explain what the atoms are and how they are to be distinguished from other things which are undivided.

Conceivably also the atomists could also claim there aren’t really any “macroscopic bodies” at all. This would mean that no atoms ever touch to form large clusters or that any large body “really” has void between its atomic parts. This may run into a problem with the description of the world at §563, (in K, R, S) above:

> “[...] becoming entangled, unite their motions and make a first spherical structure. This structure stands apart like a ‘membrane’ [...]”

This produces a problem because it appears based on this passage that the atoms were actually joined together somehow. In particular the use of "entangled" is of note.

With this, I leave Lewis' interesting heterodoxy, and begin the next subsection.

IIb - Sorabji

Another contemporary account of the motivations behind Democritean atomism is Richard Sorabji's (1983) account. In this part of my work I will analyze his comments on the matter and see how they contrast with those of Lewis (1998). I will first try reading the passages he selects as his evidence with Lewis' reinterpretation of a[toma (and related cognates) and retranslation of ajdiaivreton (and its related words). I will then see which translation seems most plausible. I will refer to additional texts in *On Generation and Corruption* (Aristotle 1982, hereafter GC) to that end.

Sorabji starts by explaining the part of the account that is virtually uncontested - Democritus and Leucippus are responding in some way to Zeno[1]. He starts by quoting GC from 316a10 and from 316a14. I think that much of these passages, after Lewis, do make much better sense by reading divided rather than divisible. As Lewis (1998) points out the first part of 316a14 is best read this way, as it doesn't seem to be a legitimate criticism without this reading. Let us look at it briefly again, so that it may contrast to the last part of the same section. Aristotle (1982) writes (316a14):

> "A dilemma arises if one maintains that there is some body possessed of size which is everywhere divisible [divided], and that this is possible. For what will there be to survive the division? If it is everywhere divisible [divided] and this is possible, it might be at one and the same

[1] I shall discuss later how some have thought (and how I think) there may be a more direct connection between Democritus and Leucippus to Parmenides and to other ancient natural philosophers.

time in this divided [divisible][2] state, even though the divisions had not taken place at one and the same time; ..."

Sorabji suggests that this part of the text of GC is to be read as the first stage of a paradox of divisibility everywhere. Aristotle's own solution relies on potential versus actual division. If only actual division (as in the above section) is a problem, then it seems plausible to read the first divisible/divided as divided. Sorabji points out that Aristotle considers four possibilities of what could survive the division. (He overlooks that there is an independent passage in GC that also states the Democritean atoms had size (315b29).) This analysis of the argument also seems quite correct, with the slight correction I have suggested.

We have seen how using Lewis' retranslation makes Sorabji's reconstruction a bit more plausible. Unfortunately, it also makes reading the very same paragraph from GC above with the second divisible as divided very awkward, as it then reads "if it is everywhere divided and this is possible, it might be at one and the same time in this divided state..." This conditional is silly and frivolous on the Lewis reading, and regardless, doesn't impact the Sorabji reconstruction of the argument. As we shall see later, passages like these will appear to support a fundamental confusion in either Aristotle's account of his predecessors or in the predecessors themselves.

If Aristotle meant (un)divided in the first instance and indivisible in the second instance in that particular paragraph (GC 315b25-316a4), as may be suggested, then there are several problems. The biggest problem consists in there being a tension between the two halves of the sentence. This also applies if one tried to reverse the above suggestion. This tension arises

[2] If Lewis is "allowed" to reread divisible as divided, it is surely potentially permissible to read divided as divisible. Throughout, I will insert the other possibility at each appropriate time.

because it appears Aristotle is setting up two possible opposing positions to contrast them.

I thus regard Sorabji's attempt to make sense of some of the motivation for atomism interesting but incomplete. A more thorough investigation, with Lewis' suggestions in mind, might prove fruitful. (Unfortunately for my sake it would likely have to involve very close readings of the Greek.)

IIc Furley on the Atomists

David Furley's 1967 work is widely referred to in the study of ancient atomism. I will here discuss the first part of his text, particularly chapter 6, where he talks about the atomist reply to the Eleatics. I do not intend this section of mine to be an argument *per se* for or against his positions, just an "engagement" or "dialectic" with what is there. (I do not have very strong opinions on his views on the issues, after all.)

Furley's account contains several interesting features. First, while he goes along with the orthodoxy in that he argues that the atomists responded to Zeno, he mentions the work of an earlier scholar who points out that nowhere does Aristotle (our first extant reporter of the atomist views) say that the Zenonian arguments are actually what motivated the atomic hypothesis. It is pointed out that Aristotle just gives arguments which supposedly (according to Aristotle) yield atomist conclusions. (I note that I have pointed this out above, particularly with regards to Aristotle's discussion in the sixth book of the *Physics*; Furley focuses primarily on passages in *On Generation and Corruption* and *de Caelo*.)

Second, he argues that Leucippus and Democritus were possibly not just physical atomists (i.e., that they believed there were objects in the world that were indivisible) but also conceptual atomists as well. He presents several texts of Aristotle (particularly from *de Caelo* Γ 4) where Aristotle's arguments against the atomists takes a mathematical tone (I use his

translation, however, note that "indivisible" in the first phrase actually is "a[toma"[3] and not "ajdiaivreton"):

> "Moreover, they must be in conflict with mathematics when they say there are indivisible bodies, and rule out many common opinions and sensible phenomena, which have already been discussed in the works on Time and Motion."

Furley argues at length for several pages that Leucippus and Democritus must have held that there were theoretically (or "conceptually") indivisible magnitudes in order to make sense of the above kinds of arguments against them by Aristotle.

I find this account unconvincing for one particularly important reason. An appeal to a conflict with mathematics, as Aristotle does use, requires a certain understanding of what mathematics is. If mathematics is regarded as purely "theoretical" (i.e., does not refer to the real world directly), as it is by many thinkers today, then Furley's account of Aristotle's criticism tends to work. But I have just stressed that this is a modern conception of mathematics. I understand there is much controversy over how mathematics was said to relate to the world in ancient Greece. Plato, for instance (see the *Timaeus*), seems to have thought that astronomy and (musical) harmony are branches of mathematics. Further, there is dispute over whether Euclid's geometry[4] was meant to be an actual description of reality. If it was, geometry would presumably conflict with the atomist conception of reality without appealing to "theoretical indivisibility." On this account, Democritus would presumably have responded to Aristotle's criticism of him via geometry

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[3] I raise this issue, as it appears that undivided bodies do not seem to conflict with mathematics. After all, a line segment or a piece of a plane is in some sense an undivided mathematical body. Thus if one wants to agree with Lewis' reinterpretations (see section IIa) one has to explain what Aristotle has in mind here.

[4] Note that I am not being anachronistic by inserting the "Euclid" here, as the whole point at issue here is whether the atomists had another geometry, where geometry here is taken to be a physical geometry. In the modern context, there are actually 3 broad and mutually exclusive though interrelated classes of geometries, mathematical, philosophical, and physical. (See Bunge 1977 for more on this distinction.)

by simply disagreeing. If Euclidean geometry is supposed to be a physical geometry or even perhaps a general physics, it can just simply be asserted to be false (i.e. that it incorrectly describes the world), and that proofs of (infinite) divisibility using it are either fallacious or beg the question[5].

Furley eventually gives up on this line of attack in understanding atomism because he says it is "riddled with paradoxes". Part of it may be a failure to fully appreciate ancient conceptions of geometry and mathematics. This simply means that we do not know how to take the nature of Euclid's work, and so to "interpret" Aristotle and Democritus' "disagreement" in that light is futile.

The next point of issue in Furley's work I would like to discuss concerns his report of Simplicius' account of Aristotle's use of undivided and indivisible[6] in atomist contexts. The point here is Aristotle did recognize that perhaps the atomists were equivocating on the meaning of ajdiaivreton amongst these three possibilities: (a) the divisible but not yet divided; (b) the absolutely indivisible because it is partless (for a remark on this, see below), and (c) that which has parts and magnitude (size) but is impervious due to its hardness and compactness. Furley correctly points out that Simplicius probably thought that having magnitude means having parts. However, Furley should also have pointed out that Simplicius could have offered to combine several of these notions of indivisibility, as they are mutually compatible. B is very plausibly joinable with (c) in an atomist context, as it does rely on the vagueness of partlessness, of which I will discuss below.

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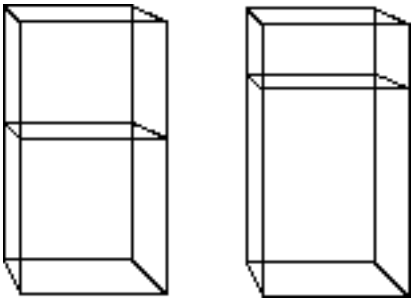
[5] The Euclidean postulates that between every two points we can draw a straight line, and that there is at least one point are presumably what an atomist arguing against the physical reality of Euclid's geometry would deny.

[6] I note that Furley seems to be aware of the ambiguity that Lewis (1998) points out surrounding ajdiaivreton but does not seem to make an issue of it. (As we shall see, he in fact waffles amongst the two meanings.)

Next, I would like to address Furley's comments on partlessness and indivisibility, as similar views are taken for granted by various other writers. It is taken for granted that partlessness necessitates absolute indivisibility. Why? Lewis (1998) points out that one need not conceive that because something is "splittable" into two entails that it was composed out of the two. Perhaps the process of splitting produces something new. (This would not be a forbidden creation *ex nihilo* either, as on this account, the production would be "out of" the preexisting matter.) This is important, as it does allow for the curious consequence of permitting physical divisibility that does not require mathematical divisibility. Here mathematical divisibility is taken in the sense of mathematics as an enterprise that does not purport to refer to the real world.

As noted above, the notion of partlessness is a bit vague. Imagine a perfect, uniform, "mathematician's" rectangular prism. It has parts in so far as one can imagine a plane passing through it and there being the top part of the prism and the bottom part of it. But the prism isn't COMPOSED out of those parts any more than it is composed by the division produced by a slightly off center plane. See figure 4 below - (a) is no more or less composed out of the two pieces than (b) is:



(a) (b)

Figure 4

This allows us to make an important distinction between actual parts and conceptual parts. This in turn provides us with another tool to get a handle

on how the atoms could be physically indivisible (or undivided) and not “theoretically”. The theoretical divisions are of theoretical parts. There is also no reason to suppose that the hooks and barbs that the atoms are said to be are any more than conceptual as well (figure 5). This figure is supposed to represent how a barbed atom would look from the side and from slightly above (ignore the stippled part; this is just to create the illusion of three dimensionality). Where does the barb end and the “other part” begin? Having no sufficient reason to place the “beginning of the barb” here, rather than there (I am of course relying on an indifference argument here - see below and Makin 1993), the atom, with its barb, are all one part.

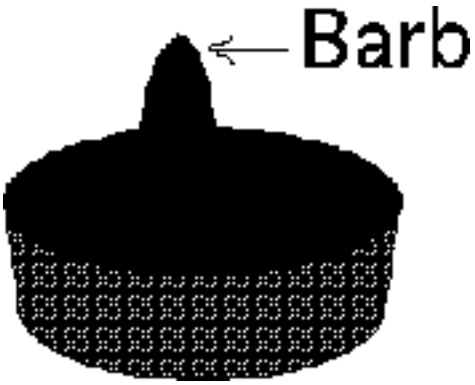


Figure 5

My final comments on this particular work of Furley’s concern whether there were “large atoms”. Furley writes of a controversy concerning the possible sizes for atoms. He references a passage from Epicurus which takes issue with the supposed Democritean assertion that the shapes of atoms are infinitely varied because it would mean that some were infinitely large. Furley neglects to have pointed out another way in which this passage can be regarded as spurious. This other way is to suggest that perhaps what Democritus was intending is that the atoms could be indefinitely large. (I understand that a[peria and its cognates can mean this notion as well.) This would mean “atoms as large as you like”, but never infinitely (i.e. greater

than any natural number in length) sized[7]. Furley next provides a reference to Lucretius (II 475ff) which is now unusable to support his (Furley's) views on the size of atoms. Lucretius (1977) writes:

> "Since I have proved this point, I next move on to its dependent theorem: that the atoms exist in a finite number of shapes. If this weren't so, some atoms, by turnabout, would have to be of infinite magnitude. You see, within the limits of small size the shapes of matter cannot vary much from one another. Suppose our basic bodies possess three minimal parts, or slightly more. When you arrange these parts within one body, spotting them top and bottom, right and left, you will have found the shapes that each arrangement of that one body can give - all that there are."

This passage cannot be used to support the notion that Democritus thought or didn't think that the atoms could be infinitely large. Even with a doctrine of "minimal parts" composing the atoms, such as the Epicurean one Lucretius is expounding in this passage, the atoms could vary considerably in size if there were no upper bound to the number of minimal parts.

Furley has another work, *The Greek Cosmologists* (1987), which has one new issue concerning the atomists I would like to discuss next. (The fact that this work is regarded in part as a "text book presentation" of his earlier work is of no consequence here, as he does present some new arguments.)

Furley focuses a fair bit of his discussion on the geometrical versus physical atomism issue I have remarked on previously. He mentions the passage in Plutarch concerning what is known as "Democritus' cone"[8]. I agree with the conclusion that he draws, that because we do not have Democritus' answer to the dilemma posed, we cannot decide between the two possible alternatives. This is assuming, however, that Lewis is incorrect about ajdiaivreton. If Lewis

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[7] I regrettably forget the reference, but there has been some recent discussion surrounding the possibility that the "lines" in Euclid's *Elements* are to be taken as being possibly indefinitely long. This is an interesting, though not terribly important coincidence.

[8] The story of Democritus' cone goes as follows. Consider a cone, and cut it into two pieces, one a smaller cone and another a fustrum of the cone. Consider the surfaces produces by your cut. Are they the same area, or not? If they are the same area, then the cone appears to be a cylinder. If they are not the same size, then the cone is not smooth and is something like a ziggurat. Democritus' answer to this dilemma does not survive.

is correct, however, there is another possible solution to Democritus' cone, namely that the cone may very well be divisible into two parts anywhere one likes, as each piece of the cone that remains is thereby undivided is hence, an atom, as we have seen. (For this consequence of the reading of ajdiaivreton as undivided, see section IIa of this paper.)

Now that I have remarked sufficently on Furley, let us move on to Makin's most interesting discussion of indifference arguments.

IId - Makin and the Indifference Arguments

As we have seen in previous subsections above, I rely heavily on the views of Makin (1993) in understanding many of the atomist arguments and the arguments to which they are likely reacting[9]. I shall here explore the details of this claim and his general account of atomism. A central point here will be that it is impossible to understand ancient atomism without a grasp on the indifference arguments employed in this context.

Makin first uses the account of indifference arguments to discuss the atomists at page 8. (All references within this subsection are to Makin 1993 unless otherwise stated.) He explains that looking at indifference arguments is a good way to look at the conflict between the atomists and Zeno. I will examine Makin's case for the use of the indifference arguments. (As we have already seen, I recognize the importance of these kinds of arguments, so this section of the present paper will be in part an attempt to work out more of this importance.)

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[9] Indeed, as Makin points out, Aristotle adopts this strategy of arguing when responding to the atomists. I have not surveyed enough of the Aristotelian corpus to tell whether Aristotle ever uses it when not responding to the atomists. It appears likely (as we shall see) that he uses this particular form of argument against the atomists because it is an argument form they liked to use. He is hence "fighting them on their own terms", which is remarkably charitable - or not, depending on how you view it. It could just as easily be viewed as an covert attempt to say "Look how silly the atomists are! Their own style of arguments lead to their downfall."

Makin next gives us a discussion of the difference between philosophical accounts and scientific ones, and flags that this may be regarded as anachronistic as far as the atomists are concerned. He is correct to point out that presocratic atomism is not a scientific account in the sense that there are no appeals to experiment or empirical evidence used to support it. (Except, I might suggest, the possible appeal to the senses concerning the juxtaposition of things with zero size, and perhaps also what Aristotle reports as the “ash can” example. We shall see these points a bit later.)

This distinction I think is important, but not for the reason he suggests. He suggests that this distinction is useful in drawing some “discipline boundaries” in Democritean thought. The present paper is not about anything other than the reasons behind the atomic account, so I need not directly concern myself with the other parts of the Democritean corpus. This is of course no reason to dismiss Makin’s division. However, his attempt to partially remove the atomic account from the “theory of nature” (p. 9) I do not think is a good one. To this end he distinguishes between the “philosophical Democritus” and the “scientific Democritus”, suggesting that the atomistic hypothesis may belong more to the “philosophical Democritus” than is commonly thought. This reevaluation is not suggesting that atomism does also not belong to the “scientific Democritus”. Hence, at this point I wonder about the motivation behind dividing his account in the first place. Makin says that depending on how one takes Democritus to be (either as one or the other) will affect one’s account of atomism. I agree with this thesis. However, from this it does not follow that one should make the division for any reason except to bring out this point. What is wrong with just taking Democritus as a reasonably unified thinker like one treats most other ancient philosophers? (For instance one normally treats Aristotle this way, who was also a very wide ranging thinker.)

After introducing the distinction, he describes the scientific Democritus as the one that is concerned with responding to the Eleatic

problems, particularly those of Zeno and Melissus. On the other hand, the philosophical Democritus is supposed to be the one that recognizes that the Eleatic arguments are self-defeating in some way. I see no reason to divide Democritus this way. Since as Makin himself already pointed out, there's no clear sense in which there was an independent science at the time. Eleatic arguments against pluralism and meaningful discourse would be regarded as attacking two parts of a greater whole - the whole of philosophy.

Makin suggests that the scientific Democritus' account of nature would be one that the philosophical Democritus could "point to" in face of the Eleatic problems, saying that it "could be like this", without necessarily committing himself to it. I am not suggesting that Democritus stubbornly held his "scientific" views (nor am I suggesting he did not), but this seems to make Democritus somewhat wishy-washy without much gain. However, Makin's point can be made without this division into halves, and it is a good one. The point is simply that Democritus was doing something like an "inference to the best explanation." He writes that most of those who have written on the atomists, from antiquity onward, have taken Zeno as the primary motivating factor for the atomic arguments. As we shall see below, I think this is true as well, but <u>also</u> recognize influence from Parmenides directly on the atomists, as well as possible influence from Anaxagoras.

This brings us to the indifference arguments, which Makin places in the camp of the "philosophical Democritus". I will skip discussing the chapters on the Eleatic predecessors found next in Makin's book (as they are important to grasp but not important to talk about here, except as the sections on Democritus refer back to them) and move on to the first section on the atomists, "Indifference and Indivisibility[10]".

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[10] I shall talk more about this in section four of the paper, but it is important to notice immediately that in this section I shall ignore the controversy of Lewis' retranslation of ajdiaivreton (and so on).

Homogeneity is said to ground indivisibility. That is, the introduction of void allows macroscopic bodies to be divisible because they aren't homogeneous and allows the atoms to be indivisible, and hence (on the usual account) not vulnerable to the Zenonian paradoxes. But why would homogeneity grant indivisibility? The indifference argument is supposed to be at work here, which goes as follows. There's no more reason for it to be divisible here rather than there, so it is not divisible at all. (This is said to be an argument for the monism attributed to Parmenides.) Introduce the void, and there is a sufficient reason for a macroscopic body to be divisible here rather than there, as there is a "crack" in it - a crack of void. This presupposes, as Makin is quick to point out, that the atoms were not in contact. There is some controversy here; I regard the evidence of the following parts of passage 563 in K,R,S to be fairly convincing to the effect that atoms were allowed to touch:

> But when their multitude prevents them from rotating any longer in equilibrium, those that are fine go outwards towards the surrounding void as if sifted**,** while the rest 'abide together' and, **becoming entangled**, unite their motions and make a first spherical structure. This structure stands apart like a 'membrane' which contains in it all kinds of bodies; and as they whirl around owing to the resistance of the middle, the surrounding membrane becomes thin, while **contiguous atoms** keep **flowing together** owing to contact with the whirl.

Saying that atoms could be entangled together without touching would require some sophisticated account of inter-atomic repulsion which there is no reason to suppose the atomists held. (After all, there is no likely mechanism one could propose that would be consistent with what the atomists knew and postulated about things. Any such mechanism would strictly be ad hoc, and it is important in the interests of charity not to posit *ad hoc* hypotheses on the ancients without good evidence.) The phrase "contiguous atoms" seems to clinch the view in favour of contact of atoms.

Makin then tries to explain how assemblies of atoms could be still divisible on this account even with contiguous groups of atoms. Here we have to move into (as he puts it) more physical reasons, of which he suggests

three. The first reason he suggests is: the atoms were said to be hard - they could be so constituted that nothing could ever divide them. Second, he suggests that perhaps it was on account of their smallness. (This can be looked at as follows. If one imagines a pestle crushing a grain against a mortar, there comes a point where one cannot crush (and hence make something into smaller pieces) anymore due to the smallness of the pieces of stuff in question[11].) Makin's third suggestion is to think of the atoms as partless; if something is partless, it is not composed out of anything, and hence cannot be broken down into parts. Finally, he suggests that the homogeneity of the atoms might be the way to ground their indivisibility. As we have seen via his "preview", this latter point is ultimately the one he accepts. I agree with this conclusion, however, I think there are places where he is a bit hasty in dismissing the other reasons. (Some of them, taken suitably, reinforce the account he ends up giving.)

Makin rejects the third alternative, claiming that we know the atoms had parts. I think he does this somewhat prematurely. As I remarked above in the section on Furley's views, it is not clear what a part of something is under certain circumstances. Since Makin is the recent thinker who focuses on the indifference arguments, I shall give an indifference argument against my account of parts above and then show where it is mistaken. The argument goes something like this. We know that the atoms had parts (e.g.: hooks and barbs); hence because they have at least two parts there is sufficient reason to have them divisible here (at the boundary of parts) rather than there and so they are in fact divisible. But we have seen in my remarks on Furley that this presupposes that the parts are distinguishable - one can have a partless atom with notional parts without wild contradiction. So partlessness can perhaps ground the indivisibility after all. (Of course, as Lewis (1998) points out this just as easily can ground undividedness. I actually think this particular account of parts works better on the Lewis reading.)

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[11] I owe this way of looking at things to Bachelard 1975.

Makin thus moves to the smallness account, which is rejected on the grounds that atoms came in different sizes, some large and some small. Here the textual evidence is a bit unclear. Most recent doxographers have been puzzled by statements like the one of Dionysius *ap*. Eusebium reproduced as §561 in K,R,S:

> "To this extent they differed, that one supposed that all atoms were very small, and on that account imperceptible; the other, Democritus, that there are some atoms that are very large."

I don't find this part of Makin's account at all satisfactory. Makin doesn't provide any references to the passages he has in mind; I can only assume he is thinking of passages like the above. We don't know what is meant by "very large" here - it could only mean very large in relation to the atoms of Epicurus, whom the Democritean atoms are being compared to here. (After all, there is no absolute sense of "very large" anyway.) In the modern context, a cesium atom is very large (around five hundred and eighty times bigger in volume) compared to a hydrogen atom (Zumdahl 1993), but that doesn't mean that a cesium atom is very large in any sort of absolute sense. (And certainly not compared to any macroscopic bodies!)

There is no reason to rule out smallness as being part of the ground for indivisibility even if there are "large atoms", as even the largest ones could be small enough to avoid being crushed. In the mortar and pestle analogy above - there comes a size where the pestle cannot break the fleck of grain down further. But that does not entail that all flecks of grain too small to be broken by the pestle are the same size! Of course, the problem with this account is that there are different sized things corresponding to the pestle in the world. Since different sized pestles are unable to crush different distributions of smallest parts, perhaps this metaphor is misleading after all. I don't think this charge is fair, however. For one thing, the smallest thing that conceivably crush something else itself has a certain minimum size. Perhaps the atoms could not "crush" other atoms and so "self-crushing" limits

atomic size. I do not mean to suggest this as a way the atomists may have thought, however, simply dismissing smallness as a ground for indivisibility the way Makin does is premature without this consideration.

Makin moves onto the hardness claim next. Here again I have problems with his dismissal. He says that any account using (absolute) hardness would simply beg the question against Zeno. I agree with this charge, but on those grounds we cannot simply rule it out, even on the principle of charity. Zeno assumes that there is no absolute hardness; the atomists disagree. Who's begging the question? They both are, in some sense. It does not seem to be fair to say that the atomists beg the question simply because they came later in history. In the modern context, we would hopefully settle this debate via experiment, not a priori, though it is unclear how one could discover that something is absolutely hard.

Finally, Makin moves into an account based on impassivity (solidity) and homogeneity. It is at this point where he brings the indifference arguments to bear. Makin makes the interesting suggestion (which I have independently developed against Furley, above) that homogeneity helps explain in what sense the atoms could have had parts and at the same time be reported to be partless. He suggests that those who have adopted a "physical" reading of Democritus are often worried by this apparent contradiction. But we have seen that we need not adopt Makin's distinction between the "scientist" Democritus and the "philosopher" Democritus in order to resolve this apparent contradiction.

Makin anticipates an objection to this account, namely that the atoms were partless in some relevant sense. He thinks that this has been misattributed to Democritus from later antiquity onwards, and attempts to sketch out a reason for this claim. Part of Makin's attempt centers around who Aristotle is responding to in Book VI of the *Physics*. As I have remarked *contra* Lewis, above, there is some reason to doubt the orthodoxy that

Aristotle has the atomists in mind here. But the reason Makin gives for rejecting the atomists as the target in this section are twofold. First, that Aristotle mentions that his aim is to show that it is impossible that continuity arises out of indivisibles[12] and second, that it is unlikely that the atomists allowed for continuity between atoms. He also points out that Aristotle says explicitly that he is dealing with those who take lines and points as indivisibles.

But the first of Makin's reasons does not work. As we have seen, there is a problem with this claim as the atoms quite clearly become entangled with each other. Makin correctly points out that two atoms with square faces could come together, become homogeneous and hence become indivisible. This seems correct enough. But here, as we have seen above, Lewis' (1998) retranslation of ajdiaivreton does save the day at the cost of having to provide a mechanism for atoms sticking together. (We shall see how this might work below (section IIIa), when I discuss the relationship between Parmenides and the atomists.)

The second reason I think he succeeds with reasonably well. Finally done with partlessness, Makin moves into homogeneity. Zeno's argument is said to provide a problem to those who assert plurality; hence the atomists could have adopted something like a Parmendian one, which is a unity. But if the atoms have parts, this means that the atom is a plurality of those parts. Makin tries to develop an argument for Democritus that does not either produce the forbidden "if a particular atom has parts, it has an infinite number of parts" (call this line A) or make use of minimal parts in the way that the Epicureans did later. Makin works out a way for the atomists to deny A by having them deny that an atom has a determinate number of parts. On this account, an atom

[12] One very interesting possibility for Lewis' rereading of ajdiaivreton here is that perhaps Plato (the adopter of indivisible lines) is being conflated with the atomists because of our common reading of ajdiaivreton as indivisible. Aristotle here would be keeping them separate, as he should. On this account, Plato would have used ajdiaivreton one way (as indivisible) and the atomists would have used it other way.

has as many parts as one would like, but always a finite number. Makin then raises the worry that this view may be too subtle, and that this may allow for divisibility in thought. Makin defends his claim against these two objections quite satisfactorily, but neglects to point out the "subjectivity of parts" view point I have presented above in my response to Furley. He almost "gets it" when he discusses how something can have parts and yet not be composed out of them.

Makin then recognizes that his account of grounding indivisibility in homogeneity does leave a few unsatisfactory threads dangling. He regards the most important one as the possibility of an infinite number of atoms in a finite area. This could occur, according to Makin, because there (by the indifference argument) could be atoms as large as you like or as small as you like. But this seems to miss the point of the Zenonian problem. Precisely because it was thought that an infinite number of things with extension must have a infinite extension, the atomists posited a way to avoid having an infinite number of things in the same place. Makin's claim that the atomists are vulnerable to having (say) a 1-unit sized atom covered by a 1/2 unit sized one, a 1/4 sized one, a 1/8 sized one and so on and hence an infinite number of "parts" of an atom and hence becoming vulnerable to the Zenonian problem again presupposes that there can be an infinite number within that finite area, which seems to be exactly what the atomists want to deny[13].

I find that Makin's introduction of the indifference argument to appeal to homogeneity of the atoms ultimately succeeds. With the brushing up I have suggested, it should get built into the general account of ancient atomism. We shall see this in section four of the paper.

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[13] The atomists do not want to deny that there are an infinite number of atoms of indefinite variation in shape and size. They would deny that they can all be within a finite volume. A possible mechanism for this would be the like-to-like mechanism I will discuss in section IIIa, below.

IIe - A Good Try - Pullman's brief account

Pullman's 1998 work is an attempt to do the entire "western" history of the "atom" concept in one volume. He devotes one chapter to Leucippus and Democritus (as well as to Epicurus and Lucretius), which I shall discuss extremely briefly here. Most of what he writes is unoriginal and derives (and is acknowledged as such!) from other sources we have looked at. However he does stress two main points, one of which I have been somewhat overlooking so far.

He emphasizes that the void is just as an important part of the atomist account as the atoms are. (History would have been a bit different if the atomists had got the name "voidists" or something like that - it might have made for some rather interesting *ad hominem* attacks.) Most of the other modern commentators tend to focus on the reason for the atoms themselves, without too much consideration of the other half of the picture. This is strangely in opposition (as Pullman points out) to the tactic of many of the ancient commentators and repliers to the atomic account. Aristotle, for instance, did not take the atomists to task as much for positing magnitudes which are ajdiaivreton, as for positing void.

His second main point that I find interesting is his claim that Leucippus did not attribute weight to the atoms, and that opinions amongst scholars as to whether Democritus or Epicurus introduced this concept were divided. As I remarked in the introduction, I find insufficient textual evidence (or indeed, insufficient text simplicter) to support any way of distinguishing the views of Leucippus and Democritus, so I wonder what Pullman has in mind here. No reference is provided. Perhaps he is referring to the work of Bailey which attempts to distinguish between the two, which according to Kirk, Raven and Schofield 1995 hasn't garnered much support.

IIf - Hankinson on Atomistic Causes & Explanations

There is some material in Hankinson's (1998) account of atomism. I

extract two main points worth engaging that we have not already examined elsewhere. First, he relates the atomist account of atoms and void to the doctrines held on sense perception. Second, he considers the reasons for positing an infinite void.

Hankinson relates the atomic view on sense perception to the views concerning atomism as follows. He points out the problem with asserting that reality is fundamentally different from what the senses tell us it is like. This would be a claim of self-undermining via the empiricism that Democritus accepts. So the atomist account has to both deal with the Eleatic worries, as we have seen, as well as avoid creating an account that is self-undermining.

How does this work? The atoms must produce some sort of influence on us in a way that is somewhat reliable. Hankinson points out that this might work through an account of secondary properties. It is not clear how the atomists could ground the secondary properties, since the atoms are all basically the same stuff, just arranged in different ways. Hankinson points out one way - influence on other atoms in a (human) body to produce phenomenal effects. Whether Democritus allowed this kind of influence is unclear. This is relevant to our present purpose, as the various powers of the atoms might well tell us more about the motivation for positing them. Hankinson suggests that Democritus would have been a thorough reductionist, rejecting the reality of anything but atoms and the void.

He sites the very famous passage concerning Democritus' viewpoint on this subject. Democritus is said to:

> "sometimes abolishes the things which appear to the senses, and says that none of them appears in reality but only in opinion, the reality in things being the existence of atoms and the void:
>
> > by convention sweet, by convention bitter, by convention hot, by convention cold, by convention colour; in reality atoms and void."

This passage does seem to rule out the possibility that atoms had any

causal powers in the secondary property sense. But this view turns on what one takes "opinion" to mean. Could the atoms cause opinions, which in turn would be certain collections of atoms and void? The textual evidence for this claim is uncertain. Passage 553 in K,R,S dimly suggests this possibility, where Sextus reports on a work of Democritus on sense perception (underlining added):

> "In the *Confirmations*, although he had promised to assign the power of assurance to the senses, he is none the less found condemning them, for he says: 'But we in actuality grasp nothing for certain, but what shifts in accordance with the condition of the body and of the things which enter it and press upon it."

The condition of the body for an atomist is surely the configuration of atoms and void spaces within it. And via the pressing mechanism, we have the explanation for the formation of opinion, if opinions are taken to be certain kinds of clusters of atoms. There is no evidence that this is indeed what the atomists thought concerning opinions, so we have therefore an incomplete account of the atomist account of senses. We have thus seen that even an account of secondary properties (in terms of causal dispositions to enter bodies and produce opinions) is possibly attributable to the atomists without compromising the picture of "merely atoms and void."

The second point of interest in Hankinson's work that should be examined is the claim that we do not know why the atomists postulated an infinite void. This remark is especially curious, because it occurs immediately after his discussion of the indifference arguments (see section IIe above). There is a very obvious *ou mellon* argument to ground infinite void, much like the Parmendian argument to ground limitless being. Why this amount of void, rather than that? Hence there is unlimited void. (See also my account of Melissus' relation to the atomists, below.) This form of argument can also be used to ground the infinity of the atoms and the infinity of *kosmoi*. An infinite "space" (amount of void) also seems to be required for an infinite amount of atoms, so if the atomists were already committed to an infinite number of

atoms by Eleatic problems, the infinite void would just tag along as a necessary consequence. Hankinson's suggestion that the atomists may have argued that a limit to something insubstantial (void) made no sense seems plausible, but I find it a weaker argument than the two I have suggested.

With these remarks on Hankinson finished, we can now move to the third section of this paper, which concerns itself with the relations between the atomists and other ancient philosophers.

Section III - Democritus and other ancient thinkers - Parmenides et. al.

In this section, I shall examine the possibility that Democritus was influenced by several other ancient thinkers. I shall start with Parmenides, examine a strange passage connecting Anaxagoras to the atomists and further, the general Anaxagoras-atomist connection in this light, discuss the ubiquitously discussed relation to Zeno, look over the possibility of a relation to Melissus. Finally I will then briefly discuss Aristotle's reaction to them generally speaking. I shall not dwell on the latter point as I am primarily interested (see the title of the present work) in the reasons for atomism.

IIIa - Parmenides and the Atomists

The most famous fragments of Parmenides consist of the following (here reproduced together, translations as used in Kirk, Raven and Schofield 1995), passages 296-297:

> "It never was nor will be, since it is now, all together, one, continuous. For what birth will you seek for it? How and whence did it grow? I shall not allow you to say nor to think from not being: for it is not to be said nor thought that it is not; and what need would have driven it later than earlier, beginning from nothing, to grow? Thus it must either be completely or not at all. Nor will the force of conviction allow anything besides it to come to be from not being. [...] Nor is it divided, since it all exists alike; nor is it more here and less there, which would prevent it from holding together, but it is all full of being. So it is all continuous: for what is draws near to it what is."[14]

[14] I note that this translation (the K,R,S one) is rather different in the last sentence from that used by Furley (1967). His translation has "So being is continuous (holds together); for being is next to being." It also has "divisible" rather than "divided" in the first sentence.

There are quite a few possible similarities between the Parmendian “one” and a Democritean atom. I shall extract five from the text above, three well recognized and two similarities which have perhaps been somewhat overlooked. Firstly, they are both eternal in the sense that “the one is” and that “atoms are (never created)”. The atoms are also continuous within themselves (Aristotle 1991 at 985b), and “the one” is continuous within itself. “The one” is also said to be not “more here and less there”, which also applies to the atoms, as they are homogeneous at least in one sense (reference: Aristotle 1991 at 985b[15]). All of these commonalities are commonly noted among modern historians of philosophy and science. There are, however, two parts of the fragment that are worth looking into more. Firstly, if the atomists can be taken as responding to Parmenides, then the remark “Nor is it divided, since it all exists alike” affects the earlier discussion concerning undivided/indivisible. Secondly, there is also a very interesting possibility that the last sentence in the fragment also tells us something about the atoms. I shall treat each of these extremely speculative theses in turn.

Firstly, on “Nor is it divided since it all exists alike.” As we have seen above, Lewis (1998) has advanced the case that the Democritean atoms were in fact undivided rather than indivisible. How one regards the connection between Parmenides and the atomists is going to depend on whether one can make better sense of either of the two interpretations of ajdiaivreton. If the atomists are responding to Parmenides, which seems somewhat likely given the three well recognized similarities above, it is plausible that they may have borrowed other aspects of the Parmenidean account. “all exists alike” suggests a form of homogeneity as well, but also suggests a possible reason why the atoms are undivided. This is the reason we have seen previously - if they “all exist alike” there is no sufficient reason for them to be divided here rather than there, and so they are undivided. This also suggests that they are

[15] I am referring to the phrase “of these the full and solid they call an entity”.

divisible everywhere, for precisely the same reason. That does not entail that they are at any time divided everywhere, and given that atoms (not the atoms[16]) exist forever, they must have a method of coming into being, which is the topic of the next remark. Textual evidence from the atomist viewpoint to support this issue will follow both, as they go together.

The last line in the Parmenidean passage above, if it was adopted by the atomists, gives a mechanism for the generation of new atoms without requiring the forbidden *ex nihilo* creation, and deals with how the atoms would avoid getting 'worn' down. (This latter concern only applies to the Lewis viewpoint - indivisible atoms do not get worn down, though undivided ones do. This is because they would tend to get divided at some point.)

My suggestion is that the atomists allowed the atoms to combine to form new atoms by the Parmendian mechanism. "for what is draws near to it what is" suggests that a group of atoms could recombine after being divided because of attraction amongst like atoms.

These hypotheses require textual support. First, from GC A8 326a9 (Aristotle 1982):

> "Yet Democritus says that each of the indivisible [undivided] bodies is heavier in proportion it its excess."

The issue surrounding undivided/indivisible here doesn't make much difference, however, it does say that the atoms come in different sizes. How could these different sizes come about? It is not by void within the bodies, as that only applies to compound bodies (i.e. bodies that are made of more than one atom)[17]. But we know that some atoms are said to be bigger than others. If the atoms are indivisible, again there is no problem - the atomists

[16] I shall explore this somewhat overlooked possibility shortly.

[17] Or at least as is commonly understood. I shall examine a rather overlooked passage from Aristotle's Metaphysics which may in fact call that viewpoint into doubt.

could simply posit that there are atoms of arbitrary sizes, with the problem of running into the issues concerning atomic parts that I have discussed elsewhere in the present paper.

But what of the drawing like to like?

> "For creatures (he says) flock together with their kind, doves with doves, cranes with cranes and so on. And the same happens even with inanimate things, as can be seen with seeds in a sieve and pebbles on the sea-shore ..." (passage 570 in K, R, S)

Atomist cosmology also seemed to make use of this principle. Passage 563, also in Kirk, Raven, and Schofield has (emphasis added):

> "[...] The worlds come into being as follows: many bodies of all sorts of shapes move 'by abscission from the infinite' into a great void; they come together there and produce a single whirl, in which, colliding with one another and revolving in all matter of ways, they begin to separate apart, <u>like to like</u>. But when their multitude prevents them from rotating any longer in equilibrium, those that are fine go out to the surrounding void as if sifted, while the rest 'abide together' [...]"

If we accept the Lewis reading (of ajdiaivreton, etc.), then, can we get any support for the formation of atoms by this method? I think we can, if we view all the atoms as alike in some respect. We have already seen that it is relatively safe to say that the atomists held that the atoms are 'made of the same stuff'. Movement in the void can be explained this way too. Should an atom passing through the void come near a collection of atoms (in a compound or otherwise) it will tend to this area of space- pebbles with pebbles and so on. (This is similar to the account of Berryman's (1999) work on the motive power of the void. I shall discuss this account below.)

Note that this resolves another problem with atomic motion which makes use of another indifference argument. If one takes the indifference arguments seriously, one has a hard time deciding whether void should allow movement or not. On one hand, we have Aristotle's argument in Physics at 214b12-215a1 (Aristotle 1996) which argue that an atom in the void has no sufficient reason to go this way rather than that way and hence cannot move at all. (On the

assumption, of course, that an atom alone has no natural direction of movement like an Aristotelian "matter chunk"[18].) On the other hand, perhaps it can just go any old way 'it pleases', there being no sufficient reason to force it to go this way rather than way. (As I see it, this is one way how an atomist could respond to Aristotle's objection here.)

But here we can play the like to like card. Assuming that atoms are completely matter and contain no void[19], they are "like" other bunches of matter, and thus would tend to move "here where there is matter" rather than over there, where there is just void. In fact, there is even part of the passage which suggests an attraction mechanism:

> "[...] Again, the containing membrane is itself increased, owing to the attraction of bodies outside; [...]" (part of §563 as above)

Since some of the atoms were hooked and barbed, this attraction would tend to have somewhat permanent results.

Of course, it could not have completely permanent results, or after a time all the atoms there are would bunch together in one huge "the one"-like mass. Since this hasn't happened, and in infinite time it would have (by standard ancient Greek reasoning about infinity[20]), a mechanism for separating the atoms must be available. One is known to us, namely "jostling", as in: (see the last part of §583, K,R,S):

> "[...] so he thinks they cling to each other and stay together until such time as some stronger necessity comes from the surrounding and shakes and scatters then apart."

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[18] A term I have coined to refer to a piece of Aristotelian matter made up of only one of the elements.

[19] See below for an exploration of a possible counterexample to this widely held thesis.

[20] If some atoms "started" (in other words, "were ever") as being infinitely far apart, it isn't clear that they would necessarily aggregate together in this way in infinite time. This issue (that is, Leucippian/Democritean conceptions of the infinity of time) of course is somewhat off the present topic.

As noted above, Berryman (1999) has recently advanced a somewhat similar thesis, which attempts to explain how the atomists allowed for clustering of atoms. I bring this up here, as it appears to complement the Parmendian type accounts nicely. She has written on a passage from Aristotle concerning why he thought that void could not be a "cause" (ation) of motion. In some sense, then, this account is the opposite of mine. She does mention the like to like principle, but instead goes with a "path of least resistance" explanation claim. She writes:

> "The claim is simply that bodies tend to move in the direction of least resistance. Given the motion of detached atoms constantly bombarding each other, it is an empirical generalization that the overall tendency will be in the direction of least resistance. Thus void, merely because it offers no resistance, is the explanation why bodies move at a certain time, in a certain direction and to a given extent."

This explanation does give a partial explanation for motion through a void (as an indifference argument like the one Aristotle gives does seem to rule it out somewhat) but it doesn't counter the full force of the indifference argument. Couple the path of least resistance claim with the claim that atoms are attracted like to like (as we have seen) and we actually obtain a full explanation of why the atoms moved. In other words atomic motion was a tendency move through the path of least resistance to the places where there was a congregation of atoms of the same kind. (This is in contrast to a Parmendian "one" which does not move.) This account is quite speculative and relies on looking for parallels in places where there are perhaps none to be found.

In my response to Makin (in section IId above), I mentioned that he overlooks a way in which the atomists can avoid having infinite numbers of atoms in a finite volume and hence avoiding another version of the Zenonian attack. This is another use for the like-to-like mechanism and hence another way in which the atomists may have made use of Parmenides own stipulations. Since the atoms would tend to congregate like to like, all those of one size would tend to be together, and thus one could not have an infinite number in a

finite volume. For example, suppose that water atoms are of size 1/2. Then there would be a tendency of things like water in size to congregate around it - beyond a certain size, things would be insufficiently like water to congregate there, and hence there would be no paradoxical size problem. (1/2+1/4+1/8+1/16+... would just bottom out (and hence avoid the "infinite sum") at some size such that any atom smaller would be sufficiently unlike its neighbours that it could not fit together. How many terms of the series that would be necessary would depend on the other characteristics of the atoms (shape, presumably.)

IIIb - Anaxagoras and the Atomists

There is a curious, and somewhat overlooked, passage in Aristotle's Metaphysics at 1009a (Aristotle 1991) that seems to indicate that Democritus thought that void was found in everything:

> "If, therefore, it is not possible that nonentity should come into existence, in a similar way, according to them, must the thing have preexisted, namely, as both contraries at once; as also Anaxagoras and Democritus, that everything was mingled in everything; for also this latter philosopher maintained that vacuity and fullness are similarly resident in any part whatsoever; although the one of these is entity and the other nonentity."

Note that this is not making the usually recognized claim that any macroscopic or compound body contains void, but instead that all (any part whatsoever - and atoms are certainly parts. Moreover, they have parts - usually thought of as one part, but one part is still a part) do. Having void in the atoms seems rather strange, but there is Aristotle, claiming that this is so.

Are there any other reasons to suppose a direct atomist-Anaxagoras connection like this seems to suggest? Let us first look at the two cosmologies and see if we can find any similarities. (These passages are labeled §488-490 in K,R,S):

> "For **air and aither are being separated off** from the surrounding mass, which is infinite in number."
> "The dense and the moist and the cold and the dark came together here, where the earth now is, while the rare and the hot and the dry and the bright went outwards to the further part of the aither."
> "From these things, as they are separated off, the earth is solidified; for water is separated off from the clouds, earth from water, and from earth stones are solidified by the cold; and stones tend to move outward more than water."

Compare the above to the atomistic cosmology, like formatting to like formatting (passage 563 in K,R,S):

> "Leucippus holds that the whole is infinite ... part of it full and part void ... Hence arise innumerable worlds, and are resolved again into these elements. The worlds come into being as follows: many bodies of all sorts of shapes move by "abscission from the infinite into a great void; they come together there and produce a single whirl, in which, colliding with one another and revolving in all manner of ways, they begin to separate apart, like to like. But when their multitude prevents them from rotating any longer in equilibrium, **those that are fine go outwards towards the surrounding void as if sifted**, while the rest 'abide together' and, becoming entangled, unite their motions and make a first spherical structure. This structure stands apart like a 'membrane' which contains in it all kinds of bodies; and as they whirl around owing to the resistance of the middle, the surrounding membrane becomes thin, while contiguous atoms keep flowing together owing to contact with the whirl. So the earth came into being, the atoms that had been borne to the middle abiding together there. Again, the containing membrane is itself increased, owing to the attraction of bodies outside; as it moves around in the whirl it takes in anything it touches. Some of these bodies that get entangled form a structure that is at first moist and muddy, but as they revolve with the whirl of the whole they dry out and then ignite to form the substance of the heavenly bodies."

There is very little in common otherwise between the two cosmologies and does not provide us with much information on why the atomists postulated things that were ajdiaivreton, or whether atoms contain void. Here are the similarities I see. First (see the underlined passages) both the atomists and Anaxagoras seemed to think that there was an infinite amount of 'stuff' in the world. Second, (see the bold passages) the lighter components[21] are said to be "winnowed out" from the rest of a bulk of matter.

Note also that in an attenuated sense, the atomists also believe that "everything is in everything", as Anaxagoras did. But the case of the atomists

[21] I am making the plausible assumption that Anaxagoras thought that air and aither were light matter.

this just means that any macroscopic body contains their two “elements”, atom and void. (This issue is not discussed in the cosmologies). Also note an important difference between the two cosmologies (see the boxed passages): Anaxagoras thinks that hot and fiery things are (so to speak) primordial; the atomists postulate that fiery things only came to be as a derivative product of motions of other things.

At the present time, however, I conclude that Aristotle’s remark that we started this subsection discussing is spurious or results from sloppy writing. I cannot find any other passages (from Aristotle or otherwise) suggetesting anything remotely like it.) The other place of greatest similarity between the atomists and Anaxagoras concerns their respective cosmologies, which as we have seen, do not seem to support (or deny, for that matter) this passage. Based on my survey of the extant literature on the atomists in English, none of the authors discuss this passage, so it appears there is a “scholarly consensus” that it is not of any consequence. However, the issue is worth exploring should any more evidence come to light.

Section IIIc - Zeno

Most ancient and modern commentators on the atomists have related them most closely to Zeno. I do not have much to add to this debate. Some of my views on the relationship between the atomists and Zeno is found in my response to Lewis, above. I will make few a other brief notes here, however.

Some of my remarks concern the only extant direct quotation from Zeno. (I use the translation of passage 315 in K,R,S):

> “In proving once again that if there are many things, the same things are limited and unlimited, Zeno’s own very own words are as follows: ‘If there are many things, it is necessary that they are just as many as they are, and neither more nor less than that. But if they are as many as they are, they will be limited.’ ‘If there are many things, the things that are are unlimited, for there are always others between the things that are, and again others between those. And thus the things that are are unlimited.”

There are several points to note here. One is that the atomists accepted Zeno's conclusion - that is, they accepted that the things that are are unlimited. (I have noted already how the atomists clearly thought that there were an infinite number of atoms.) It is also interesting to note that they also accept the first limb of Zeno's premise leading to that conclusion. They accept that there are always others between the things that are. The atomists thought there was void between things that are, and since (as Aristotle tells us at Metaphysics 985b4):

> "Wherefore, they say that entity, in no respect less than nonentity, has an existence, because neither has the vacuum a being more than corporeity, and that these are the causes of entities as material causes"

A slightly different wording is used in the K, R, S translation of the same passage, but both make it clear that Aristotle attributed to the atomists the view that "thingness" applied to the void.

Another passage concerning Zeno's views that echoes future responses by the atomists is one from Simplicius, reproduced as §316b in K,R,S. He writes:

> "Unlimitedness in magnitude he proved earlier by the same method of argument. For having first proved that if what is had no magnitude, it would not even exist, he goes on: 'But if it is, it is necessary for each to have some magnitude and thickness, and for the one part of it to be away from the other. And the same argument holds about the part out in front; for that too will have magnitude and a part of it will be out in front. Indeed it is the same thing to say this once to go on saying it always; for no such part of it will be last, nor will there not be one part related to another. - Thus if there are many things, it is necessary that they are both small and large, so small as not to have magnitude, so large as to be unlimited.'"

I regard this passage as containing possibly three parts that the atomists adopted without adopting the penultimate part of the conclusion of the dilemma. (In other words, that things are so small as to have no magnitude.) First, each existent has magnitude. This extends even to the void. Each pocket of void has a determinate volume. But allowing the detachment of some parts of objects (i.e. the atoms) from each other, the atomists allow for magnitudes with "parts out in front". In the infinite void, there is always

going to be another thing with size somewhere in any given direction. Hence "no such part of it (here, the totality of what exists) shall be last."

This suggests that Zeno's reasoning prompted the atomists to conceive of the universe as a "shattered" Parmenidean one. We shall see how this works generally in section four.

An infinite void as postulated by the atomists also suggests a possible response to Zeno's Arrow paradox, by allowing for relative motion, which is ruled out (or inconceivable in) by most other ancient cosmologies. Each atom would be at rest with respect to itself, but moving with respect to the other atoms, and so they would accept the Zenonian conclusion that the arrow was indeed both at rest and in motion. But there is, alas, no reason to suppose that the atomists were aware of relative motion either, except as follows. Aristotle criticizes the atomists in the *Physics* for not giving the atoms any natural motion. There is a sense in which Aristotle's natural motions of the elements are absolute motions; for example, earth moves absolutely downward. The atoms only move relative to one another (either singly or with respect to bunches of atoms such as *kosmoi*). I am at a loss to work this kind of relative motion into the kind that would be needed by the atomists. Attributing to them this view of motion is thus implausible but not impossible. The relevance to the account "why atomism?" is important, though, should this suggestion bear fruit, if only because it tells us yet another possible reason for the postulation of the atoms.

It is also important to point out that the atomists did accept the Zenonian conclusion that what exists is infinite in magnitude. Both the sizes of void and the sizes of the atoms when taken together are each infinite. The void and the atoms both "interrupt" one another, and prevent the infinite magnitude of either from collapsing together into the Parmendian "one". There is more along these lines in Melissus' possible relation to the atomists, which I shall turn to now.

Section IIId - Melissus and the atomists

Due to Parmenides' relation to Melissus, much of what can be said about Parmenides and the atomists can also be said of Melissus and the atomists. Furthermore, many more recent commentators regard Melissus as the second most important influence on the atomists after Zeno. I will thus again will have very little to say (compared with the remarks on Parmenides, for instance). Nevertheless there are two passages of Melissus that are sufficently unlike those of Parmenides so that one can see them as possibly having produced atomist reaction. The first of these is passage 531 from K,R,S:

> "For if it were infinite, it would be one; for if it were two, the two could not be infinite, but would be limited by one another."

I think that there very plausibly was an atomist reaction to this remark of Melissus. As we saw in the last section on Zeno, the atomists accepted that there were two infinite "things", the total magnitude of the atoms, and the total magnitude of void. The atomists therefore would be making the advance that there can indeed be two actual infinities. If this were case, the atomic postulates may have developed in recognition that they explicitly denied a postulate of Melissus.

The second passage of Melissus that was possibly responded to by the atomists was passage 532, also from K,R,S:

> "Being one it is alike in every way; for if it were unlike, being plural it would no longer be one but many."

This passage plausibly had atomist influence because it suggest the "one-ness" of the atoms. We know that the atoms were all of the same "stuff" and were all equally hard. The atoms were thus homogeneous like Melissus' one. Taken together, as the atoms are the only things that really exist, they also form a one. Each of these equally applies to the void. The void is homogeneous

and uniform, as well as equally yielding everywhere. Hence it is also alike itself in every respect everywhere, which also applies to the stuff that makes up the atoms. The stuff may be arranged differently and formed into different shapes, but it is “onelike” everwhere.

Section IIIe - Aristotle

Since Aristotle lived later than Leucippus and Democritus, it may be supposed that his relevance for understanding what the atomist project was about would be somewhat more indirect than those of their predecessors. To some extent this is true. However, much of what we know of Leucippus and Democritus is preserved by Aristotle’s works. Hence it would seem prudent to see if one can extract from them some more general observations concerning the nature of the atomist account. Since we have met many passages of the Aristotelian corpus already, I shall concentrate on his critique of the void and on his account of the nature of the atoms.

As we have noted, the void is as much a part of the atomist’s ontology as the atoms are, so investigating the reasons for void (at least as Aristotle sees them) ought to give some insight into the reasons for postulating these two constituents.

Aristotle’s discussion of the void is found in a large section of the *Physics*, which begins at 213a12. This section primarily deals with the relationship of void to motion and change. In the first part of this section, Aristotle summarizes the position of the atomists as follows (from 213b2 in Aristotle 1996):

> “Their arguments are, first, that without a void it is inconceivable that there could be such a thing as change of place (i.e. movement and increase), since it is impossible for a plenum to be receptive of anything. If a plenum could receive something, two objects would be in the same place, and then you could have any number o f bodies coinciding, since it would be impossible to specify a point at which the coincidence would stop. And if this coincidence were possible, then however small a body was, it could hold the largest thing in the world, because anything large consists of small parts. So if many equal objects could coincide, there would be nothing to stop many unequal objects coinciding too.”

This argument gives us two interesting pieces of information about the atomists which I have not already touched on elsewhere. First, the argument against plenism involving motion ALSO involves an indifference argument. Namely, that once you allow two things in one place, there is no sufficient reason to forbid three, then four, and so on. Second, it tells us that large things had parts. So if there are large atoms, they have parts too. (We have already seen a way in which this is not wildly paradoxical).

Second, Aristotle also attacks the concept of the void at 215a1 by appealing to a distinction between forced and natural motion, claiming that bodies with no natural movement will not move without it. He then states that a void doesn't allow for natural movement, because within a void there is no below or center or any of the other "places" which Aristotle uses himself to define natural movements of kinds of bodies. This remark is somewhat unfair on Aristotle's part, as it does seem to beg the question against the atomists. On the other hand, there does not seem to be a way to prefer either account to the other in the absence of more support. Aristotle takes it as given that his natural motions of bodies always apply; the atomists would simply reply that they do not hold always. It is unclear how the atomists would handle the relative consistency of the motions that Aristotle uses to build his account (i.e. why earth always seems to fall down relative to our position, why fire seems always to go up, and so on). Perhaps the like-to-like principle could have been used here.

Moving on to a later passage in the *Physics*, we find the first of Aristotle's arguments against the possibility of a void. This is relevant for our present concern, as it does seem to rely on an argument from experience. This is the "ash" example, introduced by Aristotle at around 213b14, and refuted at around 214b3. This argument centers around the observation that a can of ash holds as much water as the can alone. These remarks do suggests that some of the atomistic account was not strictly rationalistic and had

(apparent) empirical support beyond the experience of motion.

The final passages in this part of the *Physics* that we should look at concern more of Aristotle's attempted refutations of the idea of void. The first of these is at 214b28, where (as I remarked on my commentaries on Berryman's (1999) paper) there is an indifference argument against the possibility of possibility of motion in a void. Aristotle writes:

> "The idea that the earth is at rest because of the equilibrium of things is analogous: by the same token, anything in a void is bound to be at rest to more or less than anywhere else because the void by definition contains no differentiation."

It is tempting to regard this (as I remarked earlier) as an attack on the atomists on their own terms. However, it does contain a subtle possible mistake on Aristotle's part. The void itself is undifferentiated, but it does have different, varying degrees of stuff in it. We have the following passage from Hippolytus, reproduced as §565 in K,R,S, to this effect (underlining added for emphasis):

> "Democritus holds the same view as Leucippus about the elements, full and void... he spoke as if the things that are were in constant motion in the void; and there are innumerable worlds, which differ in size. In some worlds there is no sun and moon, and in others they are larger than in our world, and in others more numerous. The <u>intervals between the worlds are unequal; in some parts there are more worlds</u>, in others fewer; some are increasing, some at their height, some decreasing; in some parts they are arising, in others failing. They are destroyed by collisions one with another. There are some worlds devoid of living creatures or plants or any moisture."

The inhomogeneity of the "all" coupled with the like-to-like mechanism, seems to present a problem for Aristotle's criticism, which now appears to fall flat.

With this remark, let us now turn to Aristotle's discussion of the nature of the atoms in *On Generation and Corruption* (Aristotle 1982).

In this work, there are two passages of note that I have not already examined in the context of exploring the views of other thinkers. The first of

these is at 314a20 where Aristotle writes:

> "Democritus and Leucippus say that there are ajdiaivreton bodies out of which everything else is composed, infinite both in number and in variety of shape; and that compounds differ from each other in respect of these components, and in respect of the position and arrangement of these components."

Here we have explicit recognition that there were an infinite number of atoms, and that they came in infinitely many different shapes, much as the infinite number of homeomers of Anaxagoras.

The final passage of note of Aristotle's occurs at 315b5-10. This is a curious passage in which another reason for the postulation of an infinite variety of atoms is given:

> "But Democritus and Leucippus, having got the figures, get alteration and generation from these: generation and corruption by their aggregation and segregation, alteration by their arrangement and position. Since they thought truth was in appearance, and that appearances were infinite and contrary to each other, they made the figures infinite."

It is actually unclear here whether these figures refer to atoms or the things composed out of atoms. The first use of figures suggests the atoms, and yet the second use suggests macroscopic bodies, as the next sentence suggests:

> "Changes in the compound were thus thought to give the same thing contrary appearances to different observers."

We have thus gleaned a few more possible reasons for postulating atomism from reading Aristotle's commentaries on his predecessors. I now move from my remarks on the ancient sources of atomism to my synthesis of the atomist project in section four below.

Section IV - Synthesis

In this section, I shall put together what we have gleaned from the analysis of both the ancient texts and modern views on them. I shall argue

that there really is insufficient information still extant to make much progress in any direction, particularly concerning Lewis' rereading of ajdiaivreton and a[toma.

This section will thus consist of what I consider to be the minimal account one can give of the core reasons for postulating atomism. Each point being made is disccesed at length elsewhere in the present paper.

As is normally acknowledged, atomism is a response to the arguments of Zeno and Parmenides/Melissus for monism. It answers these arguments by admitting the existence of two "ones", the atoms taken together and all the void taken together. Each of these collections together is uniform, homogeneous, the same everywhere, uncreated, undestroyed.

In turn, each atom is also a "one". Atoms are also homogenous in at least one sense, each one is equally hard throughout. Further, each one is not divided or is indivisible. If the former reading of ajdiaivreton is correct, then we get no puzzlement over the great range of size of atoms. This has the advantage of being also supported by indifference reasoning. If the latter is true we must worry over what constitutes an atom and a few passages where ajdiaivreton as undivided does not read smoothly. As we have seen in section IIa, Lewis' reading of ajdiaivreton as undivided commits us to anything undivided being an atom, which also seems to rule out atoms coming into contact.

On the available evidence, I prefer the Lewis interpretation of ajdiaivreton simply because it allows for the greater size of atoms and it supports of and by indifference arguments which do seem to play a great role in the development of the atomic concept. This interpretation, though, has to produce some sort of account as to which undivided things could count as atoms, and further, what undivided things there are. It also must have some mechanism for combining atoms into larger atoms, as we have seen that, in

infinite time, all the atoms would tend to divide themselves indefinitely. I have suggested that perhaps the Parmenidean-inspired mechanism of attracting like to like here might work. This does not commit one to saying that a fire atom could "replenish" itself with a water atom. Since it appears that the atomists did not postulate any shapes for atoms except spherical atoms for soul or fire, how this replenishing mechanism would work exactly is ultimately unclear, though nevertheless necessary.

On the other hand, if one does not like saddling the atomists with something so necessary and yet so vague and not at all spelled out, one must then read ajdiaivreton in its conventional sense of indivisible. But that creates problems of other sorts. Let us see why.

In order to save some of sense perception from the Eleatic aporia, the atomists were also required to explicitly deny some of the monism inherent in Eleatic reasoning. This meant introducing another basic stuff, the void. As I have noted, particularly on the sections on Parmenides, Zeno and Melissus, the void also has many "one"-like properties. I regard this as deliberate and perhaps, in some sense, deliberately contrarian. Aristotle (1991) reports at *Metaphysics* A 985b:

> "But Leucippus, and his companion Democritus, assert that the full and the empty are elements; terming, for instance, the one, an entity, and the other a nonentity; and of these, the full and solid they call an entity, and the empty and the attenuated a nonenity. Wherefore, they say that entity, in no respect less than nonentity, has an existence, because nether has the vacuum a being more than corporeity, and that these are the causes of entities as material causes."

Aristotle here seems to be reporting a play on words by the atomists with their explicit postulation of a "non entity". This suggests that they deliberately found a way to talk about what is not, in direct opposition to the results of Parmenides' injunctions. The postulation of void allows for motion, talk of what is not, coming-to-be and passing-away, while at the same time agreeing with the Eleatic conclusion that things are indeed very different from what they appear to be.

A final part of the minimalist synthesis concerns the place of the indifference arguments. The atomists, regardless of how one wants to read ajdiaivreton, had to find some way to account for atomic sizes and atomic indivisibility/undividedness. By borrowing the indifference reasoning of Zeno and Parmenides/Melissus, and using it to turn it against them with a few additional postulates, the atomists created an intellectual *tour de force* in the face of a paralyzing collection of paradoxes.

These postulates can actually be summed up as follows. There are four postulates of atomism. Two are the first two broad ones, and two of lesser importance. These hold regardless of one's "ajdiaivreton allegiance".

1. There is emptiness in some parts of the totality.
2. The totality of what exists is infinite in both time and space.
3. What makes up all things that are solid is maximally solid.
4. Each of the solid bits is eternally in motion and may for a time get attached to other solid bits.

We must ask: in order to advance what is known about the reasons for ancient atomism, what discoveries or explanation needs to be made[22]? This would be to gather all the Democritean fragments and parse them for ajdiaivreton, seeing if one can resolve any consistent usage (I am unqualified to do this myself, not knowing any Greek to speak of). As we have seen, there is some reason to suspect that it is being used both ways indiscriminately. Further, it is necessary to look at more fragments of Parmenides, Melissus and Zeno and see if one can extract more possible motivations.

For now, though, the question of the title of this paper "Why atomism?"

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[22] I mean something a bit more plausible than discovering the Presocratics equivalent of the Dead Sea Scrolls.

can only be answered elliptically: to answer the Eleatic paradoxes of being and becoming using as minimal a difference in ontology as possible. I have presented one way in which the atomist ontology is in fact a very slight revision of the Eleatic monism, and so this conclusion seems plausible.

In the concluding section below, I shall return to the end of the 20th century from my sojourn in ancient Abdera and further explain my reasons for doing all of this ancient history. Without this explanation, my paper is incomplete. The paper stands as a work in history, which is fine as far as it goes, but is insufficient[23].

Section V - Conclusion

There are three philosophical and scientific lessons that are relevant to the contemporary scholar that can be drawn from the story of the ancient atomists. The first is that a priorism doesn't really advance the state of knowledge in matters of fact. This is not terribly important to point out, as science has gone beyond this stage anyway since at least Galileo, possibly earlier. As we have seen, there was little in the way of contact with the empirical method in the formulation of ancient atomism. Philosophers especially should note that it takes both the empirical method and the reasoning developed by rationalistic accounts to produce good pictures of the world. This must be, at the very least to avoidng just talking past one's opponent. (Aristotle actually did a better job of this than his predecessors, as he did, to some degree, start the blending of both ways of investigation.)

The second lesson concerns ambiguous language. As we have seen, some of the controversy surrounding the issue is precisely one of language. While, of course, one cannot fault the ancient Greek milieu for not having the language to unambiguously express what the atomists meant by their primary theses, it is nevertheless true that there are always ways to avoid this problem. In our

[23] It is not sufficient as far as I am concerned, that is.

present context, this applies as well, despite the great number of words in English. If some word expresses your idea well in one sense, but is ambiguous, possibly having another sense, either use a different word, or find a way to clarify which meaning is being used. We are lucky, because today we have access to formal tools (mathematics) which can help. Our predecessors were not so fortunate. We should not be afraid to take advantage of this advancement.

Third and finally, it is also important to note that there is no gap between metaphysics and science. The ancient thinkers did not distinguish between the former two, and they had great continuity in the sciences generally. I suggest that our modern science should be integrated into a similar framework. This is actually suggested by the ancient atomist accounts[24] in two ways. First, because their accounts both dealt with the specific and the general features of the world in one framework, the atomists show us that such a framework was possible then. Why is it less tried today? Second, the atomists recognized that the universe is one, and so explanations should be systemic in character and that they should "jive well" with each other. Alas, these days there is somewhat of a problem with discipline fragmentation. (I think that good philosophy can help mend these fragmentation wounds, but first requires a healing of the fragmentation within philosophy itself.) While the atomists were not right in detail, they were in approach, in at least these respects. If we are to learn anything from the history of science and philosophy, it is that building comprehensive systems[25] is hard. But if two men from Abdera and Miletus could do it 2500 years ago, surely we can (or at least, ought to try) today.

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[24] I do not mean to suggest that these are indicated by the atomists alone. Other ancient natural philosophers can be drawn upon to get this conclusion as well, particularly Aristotle.

[25] Contrary to current belief, I do not think that building comprehensive systems of philosophy and science is dogmatic. On the contrary, building comprehensive systems (rather than advancing stray hypotheses) allows greater examination of presuppositions, consequences and interconnection between ideas, and thus better fosters debate and disagreement, and hence relevant change.

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