What Did the Ancient Epicureans Think Were The Upper And Lower Limits of Atomic Size?

Post by “Cassius” of September 6, 2024 at 9:21 AM

I am becoming more convinced of the importance of following Epicurus' advice to Pythocles to "most of all give yourself up to the study of the beginnings and of infinity and of the things akin to them..."

As to infinity at the larger scale, it is the boundless size of the universe (and the amount of atoms and void) that makes possible the coming together of all that we see around us to come together, and this makes it possible for us to understand the creation of our worlds without divine intervention. Epicurus was reasoning that if the universe were not infinite in size but either atoms or void were infinite, then things would be tight-packed or would never come together in the first place.

As to infinity at the smaller scale, it is the fact that division is *not* boundless that forms the basis of confidence that the atoms are the transmission and regulation method by which the things that we see around us work in repeated patterns. Epicurus was reasoning that the minimum size of atoms is what makes it possible for the world to operate on a regular basis without divine supervision.

So in continuing to try to trace Epicurus' thinking, I think it's any obvious question to ask:

What did the Epicureans think to be the lower limit in size, and the upper limit in size, of an individual atom?

I think there are text references either in Herodotus or Lucretius or both about this which would be worthwhile to collect.

I seem to remember that the upper limit was considered to be either (1) large enough to be visible to us (none are), or (2) so large that a single atom would crowd out the rest of the universe. My memory is wrong there because that's a huge difference in size. I seem to remember (1) being said somewhere, but option (2) makes more logical sense. Maybe there's a way to relate both from different passages.

On the downside of size there is similar discussion. I seem to recall that it all comes back to the smallest size being deduced to be something like "large enough to perform its function of carrying on the eternal characteristics of size, shape, and weight."

Obviously here i am not looking for a discussion of modern scientific theory - that can be done somewhere else.

I am looking for what we can find out about this from the Epicurean texts, because pinning down how the Epicureans reasoned on this would likely give us some important insights into how Epicurus was thinking and developing his philosophy. I'd relate this right up there with "the nature of the gods" in importance, because it's the key to understanding how the universe operates *without* the direction of the gods.

Post by “Cassius” of September 6, 2024 at 10:58 AM

Here's a section in Book 1 of Lucretius describing the lower limit in size of atoms. Seems to me as noted before that this is not an assertion of a particular size, but that whatever the lower limit in size is, it must be sufficient to carry on these requirements.

> Quote
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> [551] Again, if nature had ordained no limit to the breaking of things, by now the bodies of matter would have been so far brought low by the breaking of ages past, that nothing could be conceived out of them within a fixed time, and pass on to the full measure of its life; for we see that anything you will is more easily broken up than put together again. Wherefore what the long limitless age of days, the age of all time that is gone by, had broken ere now, disordering and dissolving, could never be renewed in all time that remains. But as it is, a set limit to breaking has, we may be sure, been appointed, since we see each thing put together again, and at the same time fixed seasons ordained for all things after their kind, in the which they may be able to reach the flower of their life.
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> [565] There is this too that, though the first-bodies of matter are quite solid, yet we can give account of all the soft things that come to be, air, water, earth, fires, by what means they come to being, and by what force each goes on its way, when once void has been mingled in things. But on the other hand, if the first-beginnings of things were to be soft, it will not be possible to give account whence hard flints and iron can be created; for from the first all nature will lack a first-beginning of foundation. There are then bodies that prevail in their solid singleness, by whose more close-packed union all things can be riveted and reveal their stalwart strength.
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> [577] Moreover, if no limit has been appointed to the breaking of things, still it must needs be that all the bodies of things survive even now from time everlasting, such

that they cannot yet have been assailed by any danger. But since they exist endowed with a frail nature, it is not in harmony with this that they have been able to abide for everlasting time harried through all the ages by countless blows.

[584] Once again, since there has been appointed for all things after their kind a limit of growing and of maintaining life, and inasmuch as it stands ordained what all things severally can do by the laws of nature, and what too they cannot, nor is anything so changed, but that all things stand so fast that the diverse birds all in their due order show that the marks of their kind are on their body, they must also, we may be sure, have a body of unchanging substance. For if the first-beginnings of things could be vanquished in any way and changed, then, too, would it be doubtful what might come to being, what might not, yea, in what way each thing has its power limited and its deepset boundary-stone, nor could the tribes each after their kind so often recall the nature, habits, manner of life and movements of the parents.

[599] Then, further, since there are extreme points, one after another \[on bodies, which are the least things we can see, likewise, too, there must be a least point\] on that body, which our senses can no longer descry; that point, we may be sure, exists without parts and is endowed with the least nature, nor was it ever sundered apart by itself nor can it so be hereafter, since it is itself but a part of another and that the first single part: then other like parts and again others in order in close array make up the nature of the first body, and since they cannot exist by themselves, it must needs be that they stay fast there whence they cannot by any means be torn away. The first-beginnings then are of solid singleness; for they are a close dense mass of least parts, never put together out of a union of those parts, but rather prevailing in everlasting singleness; from them nature, keeping safe the seeds of things, suffers not anything to be torn away, nor ever to be removed.

[615] Moreover, if there be not a least thing, all the tiniest bodies will be composed of infinite parts, since indeed the half of a half will always have a half, nor will anything set a limit. What difference then will there be between the sum of things and the least of things? There will be no difference; for however completely the whole sum be infinite, yet things that are tiniest will be composed of infinite parts just the same. And since true reasoning cries out against this, and denies that the mind can believe it, you must be vanquished and confess that there are those things which consist of no parts at all and are of the least nature. And since these exist, those first-beginnings too you must needs own are solid and everlasting.

[628] And again, if nature, the creatress, had been used to constrain all things to be dissolved into their least parts, then she could not again renew aught of them, for the reason that things which are not enlarged by any parts, have not those powers which must belong to creative matter, the diverse fastenings, weights, blows, meetings, movements, by which all things are carried on.

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Post by “Cassius” of September 6, 2024 at 11:03 AM

As to largest possible size, there is this from Book 2 of Lucretius. This seems to be the upper limit related to the idea that if an atom were of unlimited size then it would be "of unbounded bulk" which I presume means it would crowd everything else out. So this is one way of looking at the limit, but I thought I remembered somewhere a statement to the effect that we could not conceive of an atom being so large as to be detectable to our senses. If that was said somewhere, I am not sure what the reasoning would be. At any rate, the point I think is worth emphasizing is that this isn't reasoning that we identify so much as hypertechnical "science," but mostly mental logic based on common sense directly referring to what our senses tell us without any mathematics or instrumentation of any kind.

> Quote
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> [478] And since I have taught this much, I will hasten to link on a truth which holds to this and wins belief from it, that the first-beginnings of things are limited in the tale of their varying shapes. If it were not to be so, then once again certain seeds must needs be of unbounded bulk of body. For, within the same tiny frame of any one single seed, the shapes of the body cannot be very diverse. For suppose the first-bodies to be of three least parts, or if you will, make them larger by a few more; in truth when you have tried all those parts of one body in every way, shifting top and bottom, changing right with left, to see what outline of form in that whole body each arrangement gives, beyond that, if by chance you wish to make the shapes different, you must needs add other parts; thence it will follow that in like manner the arrangement will ask for other parts, if by chance you still wish to make the shapes different: and so greater bulk in the body follows on newness of forms. Wherefore it is not possible that you can believe that there are seeds with unbounded difference of forms, lest you constrain certain of them to be of huge vastness, which I have taught above cannot be approved.
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> [500] At once you would see barbaric robes and gleaming Meliboean purple, dyed with the colour of Thessalian shells, and the golden tribes of peacocks, steeped in smiling beauty, lie neglected and surpassed by the new colours in things; and the smell of myrrh and the taste of honey would be despised, and the swan’s song and the many-toned melodies on Phoebus’s strings would in like manner be smothered and mute: for something more excellent than all else would ever be arising. Likewise, all things would sink back on the worse side, just as we have told that they would rise towards the

> better. For, on the other hand, something would be more loathly too than all else to nostrils and ears and eyes, and the taste of the mouth. And since these things are not so, but a fixed limit to things marks the extreme on either side, you must needs confess that the first-matter too has a limited difference in shapes.
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> [515] Again from fire right on to the icy frost of winter is but a limited way, and in like manner is the way measured back again. For all heat and cold and tepid warmths in the middle lie between the two, filling up the sum in due order. And so they are brought to being differing with limited degrees, since they are marked off at either end by the twin points, beset on this side by flames, on that by stiffening frosts.
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> [522] And since I have taught this much, I will hasten to link on a truth which holds to it and wins belief from it, that the first-beginnings of things, which are formed with a shape like to one another, are in number infinite. For since the difference of forms is limited, it must needs be that those which are alike are unlimited, or else that the sum of matter is created limited, which I have proved not to be, showing in my verses that the tiny bodies of matter from everlasting always keep up the sum of things, as the team of blows is harnessed on unbroken on every side.

Post by “Bryan” of September 6, 2024 at 11:15 AM

We also have Laertius 43a. "for [Epíkouros] states that division [of atoms] does not happen further ad infinitum, even though (as he says) the Qualities are transformed – unless Someone is also going to extend those [atoms] completely ad infinitum in [terms of] size"

and Laertius 44b. "He says within [his books], that no Quality at all for the atoms exists except shape, size, and weight – that Color varies with the position of the atoms, he states in the *Twelve Elementary Principles* – and that concerning them every Size does not exist: never, at least, has an Atom ever been perceived by sensation"

Post by “Cassius” of September 6, 2024 at 11:44 AM

Thanks Bryan. OK - so that's maybe where I got the idea that no atom has ever been perceived by sensation, unless it's also buried somewhere in Lucretius (and my gut tells me it is, at least in passing, or implied in the discussion of images).

The "*never* has an atom been perceived by sensation" strikes me as interesting, as I presume that would be an example of an inference that would appear to me less certain than the inference that none are so large as to consume the universe. THAT one is clear, but I am not sure that it would be safe to conclude that nothing we have ever perceived is a large atom. I don't think Epicurus is suggesting that we have to have perceived an example of something here on earth in order for such a thing to exist elsewhere (so long as it is consistent with other basic physical principals).

"An atom cannot be so large as to be perceived directly by a human" does not strike me as a fundamental of physics. Does it seem that way to anyone? If so, why?

I suppose that we can observe that everything perceptible to us can be divided into smaller particles til a perceptible smallest is reached, but I am not sure why a perceptible smallest could not be an atom itself. Maybe Diogenes Laertius is talking about something in the books we no longer have that was more in the line of speculation, because it doesn't seem to be basic enough to have made it into Herodotus, unless maybe by implication.

None of this is difficult physics, it's all just common sense observation and deduction. But going through it I think gets us closer to the logical way Epicurus was thinking (not only about physics but I would bet everything else as well including "pleasure").

Post by “Bryan” of September 6, 2024 at 12:56 PM

While atoms are a mechanism for vision, they cannot be visible -- they compose the films that allow us to perceive everything else, but do not produce films themselves. We do have Epicurus on the topic at 56a. "but every Size [of atom] existing is also not useful for [producing] the differences of qualities – and It would also therefore have been necessary for visible Atoms to arrive among us (Which are not observed to be produced) nor is It possible to conceive how a visible Atom would be produced"

[Bailey] But the existence of atoms of every size is not required to explain the differences of qualities in things, and at the same time some atoms would be bound to come within our ken and be visible; but this is never seen to be the case, nor is it possible to imagine how an atom could become visible.

Post by “Martin” of September 6, 2024 at 1:06 PM

The ancients were certainly aware, that a piece of solid material could be ground such that the piece becomes smaller and the removed specs would still have color if visible or they were not visible, and that water evaporated without that they could see into what. It was straight forward to infer for Epicurus that the smallest spec still visible was not an atom and that atoms were smaller than to be seen with bare eyes. Moreover, his atoms did not have color, which adds to the impossibility to see them.

Post by “Kalosyni” of September 6, 2024 at 1:17 PM

Just in case, after everyone thouroughly understands the ancients 😇 ...if anyone wants to read about the modern understanding of atoms:

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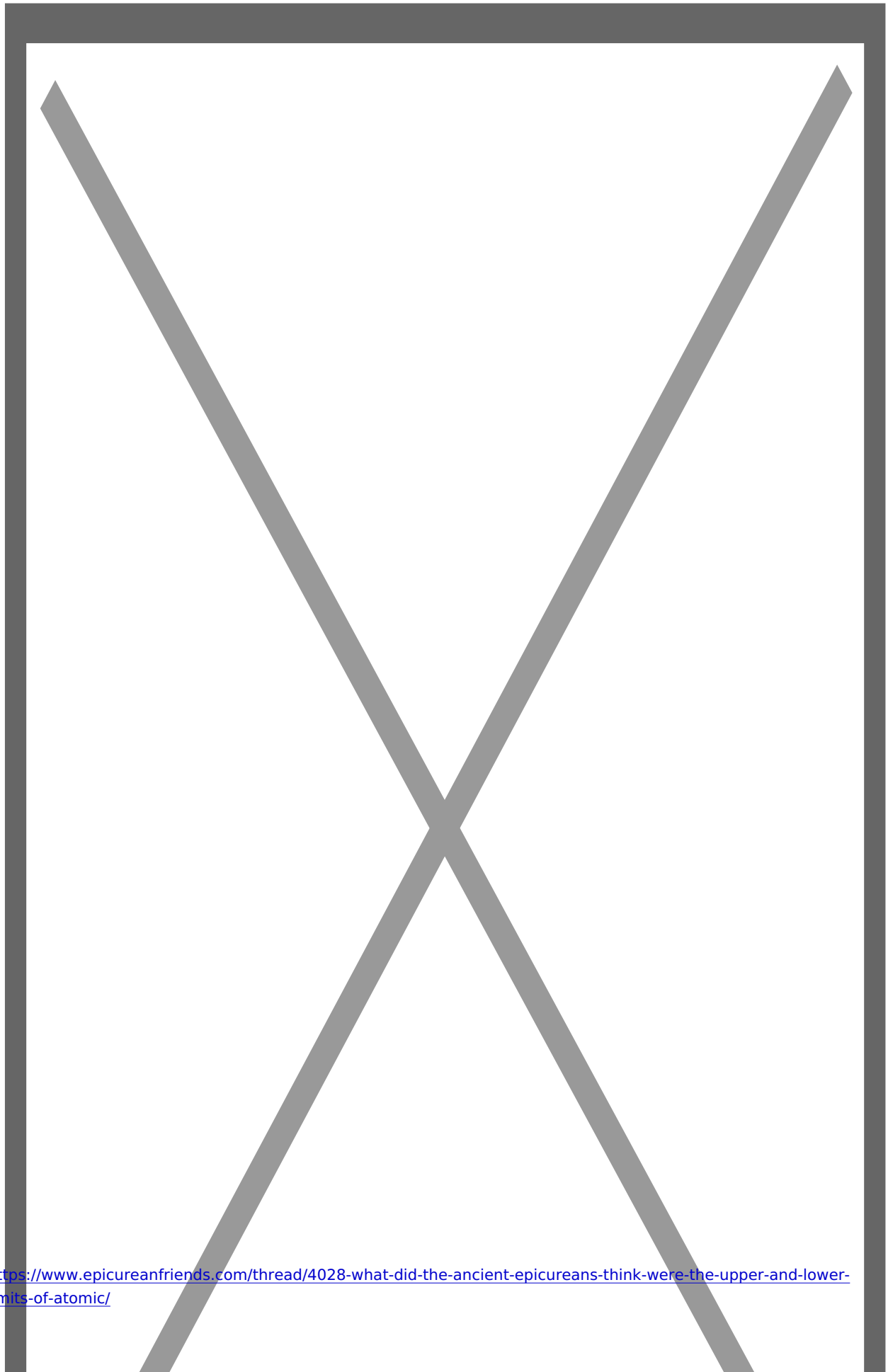

Atom - Wikipedia
en.m.wikipedia.org

Post by “Eikadistes” of September 6, 2024 at 1:38 PM

The *Epistle to Herodotus* 55-59 discusses the range of sizes of an atom:

"However, one must not believe that every kind of magnitude exists in atoms, lest we find ourselves contradicted by phenomena. But we must admit that there are atoms of different magnitude, because, as that is the case, it is then more easy to explain the impressions and sensations; [56]at all events, I repeat, it is not necessary for the purpose of explaining the differences of the qualities, to attribute to atoms every kind of magnitude.

We must not suppose either, that an atom can become visible to us; for, first of all, one does not see that that is the case, and besides, one cannot even conceive, how an atom is to become visible; besides, we must not believe, that in a finite body there are particles of every sort, infinite in number; consequently, one must not only reject the doctrine of infinite divisibility in parcels smaller and smaller, lest we should be reducing everything to nothing, and find ourselves forced to admit, that in a mass composed of a crowd of elements, existence can reduce itself to non-existence. But one cannot even suppose that a finite can be susceptible of transformation ad infinitum, or even of transformation into smaller objects that itself; [57]for when once one has said that there are in an object particles of every kind, infinite in number, there is absolutely no means whatever of imagining that this object can have only a finite magnitude; in fact, it is evident that these particles, infinite in number, have some kind of dimension or other, and whatever this dimension may be in other respects, the objects which are composed of it will have an infinite magnitude; in presenting forms which are determined, and limits which are perceived by the senses, one conceives, easily, without it being necessary to study this last question directly, that this would be the consequence of the contrary supposition, and that consequently, one must come to look at every object as infinite.

58 One must also admit that the most minute particle perceptible to the sense, is neither absolutely like the objects which are susceptible of transformation, nor absolutely different from them. It has some characteristic in common with the object which admit of transformation, but it also differs from them, inasmuch as it does not allow any distinct parts to be discerned in it. When then, in virtue of these common characteristics, and of this resemblance, we wish to form an idea of the smallest particle perceptible by the senses, in taking the objects which change, for our terms of comparison, it is necessary that we should seize on some characteristic common to these different objects. In this way, we examine them successively, from the first to the last, not by themselves, more as composed of parts in juxtaposition, but only in their extent; in other words, we consider, the magnitudes by themselves, and in an

abstract manner, inasmuch as they measure, the greater a greater extent, and the smaller a smaller extent. This analogy applies to the atom, as far as we consider it as having the smallest dimensions possible. [59]Evidently by its minuteness, it differs from all sensible objects, but still this analogy is applicable to it; in a word, we establish by this comparison, that the atom really has some extent, but we exclude all considerable dimensions, for the sake of only investing it with the smallest proportions.

We must also admit, in taking for our guide the reasoning which discloses to us things which are invisible to the senses, that the most minute magnitudes, those which are not compound magnitudes, and which from the limit of sensible extent, are the first measure of the other magnitudes which are only called greater or less in their relation to the others. For these relations which they maintain with these particles, which are not subject to transformation, suffice to give them this characteristic of first measure. But they cannot, like atoms, combine themselves, and form compound bodies in virtue of any motion belonging to themselves." (trans. Yonge)