God and the Atom by Victor Stenger: A Very Brief Review

Post by “Godfrey” of February 14, 2020 at 7:19 PM

The theme of this book is to track the confirmation and development of the atomic theory from Leucippus through the discovery of the Higgs boson and to show how atoms and void have prevailed despite continuous opposition by religious and idealist thinkers. This is a lot to cover, and I, as a non-scientist, am interested in the topic mainly to try to understand how the ancient physics of Epicurus compares to modern physics.

I see this book as a good reference book for someone interested in the subject. Stenger covers 2500 years of thought, so by it's nature as a 300 page book he can only give a cursory treatment to each step along the way. To do a deeper dive would require many volumes. It's reassuring to note that he supports Epicurus's physics. For an Epicurean well versed in physics, this book might be a pleasant review and provide material for further thought and discussion. Personally, I found the first two thirds or so to be relatively easy to grasp, the final third is quite complex and requires more serious study than I currently find necessary to devote to the subject. So while I got a lot out of reading the book, it left me less than satisfied at the end.

Stenger is an experimental physicist as opposed to a theoretical physicist. As such, he emphasizes ideas confirmed by experimental observation and states that such ideas are the only valid ones, as opposed to unconfirmed theories.

He cites the philosopher Andrew Pyle as laying out these “ideal central claims of atomism”:

1. **Indivisibles**: particles of matter either conceptually indivisible or physically unsplittable.

2. **Void**, vacuum, "Non-Being", or purely empty space in which the atoms are free to move.

3. **Reductionism**: “the reducibility of the atomic model refers to the fact that the observations we make about matter, such as the wetness of water or the color of copper, and perhaps even human intelligence, can be reduced to the motions and interactions of elementary particles that themselves do not possess such properties.”

4. **Mechanism**, which claims in effect that no body is ever moved except by an external impulse from another body.

Here are some notable quotes from the book regarding the general theme:

He begins his preface with this quote from Epicurus: “*It is impossible for anyone to dispel his fear over the most important matters, if he does not know what is the nature of the universe*

but instead suspects something that happens in myth. Therefore, it is impossible to obtain unmitigated pleasure without natural science."

"*This book will make the case that atoms and the void indeed are all there is."*

"*No one knows exactly how the original atomists arrived at their intuition. But observation must have played a role. No fact about the world has ever been discovered by pure thought alone."*

He quotes Gaston Bachelard: *"by virtue of the existence of dust, atomism was able to receive from the time of its inception an intuitive basis that is both permanent and richly evocative."*

"*My basic position as an experimental physicist is that all we know about is what we observe with our senses and instruments. We describe these with models, sometimes called theories, but we haven't the faintest idea what is 'really' out there. But, does it matter? All we need to concern ourselves with is what we observe. If whatever is really out there produces no observable effect, then why should we worry about it?"*

"*….the reduction of all we observe to the interaction of tiny bits of matter moving about mostly randomly in empty space is irreconcilable with the common belief that there must be something more to the universe we live in, that human thoughts and emotions cannot be simply the result of particles bouncing around. We will see how attempts to uncover evidence for immaterial ingredients or holistic forces in nature that cannot be reduced to the interactions of elementary particles have been a complete failure."*

"*Today we often hear it said that, according to quantum mechanics, we can never have completely empty space, as particle-antiparticle pairs flit in and out of existence. While this is true, at any given instant a volume will contain these particle pairs with empty space in between. The basic atomic model remains part of quantum physics. The matter we observe on all scales is mostly empty space with tiny particles mostly randomly moving about constituting the visible universe and perhaps its invisible parts as well."*

"*It remains possible that in some future, successful theory, the ultimate constituents or atoms of matter may not be treated as point-like (zero-dimensional) particles but strings (one-dimensional) or multidimensional "branes" (from "membranes"). Even if these models ultimately succeed (they haven't so far), the elementary structures will be so small that they will remain particulate in the eyes and instruments of experimenters for the foreseeable future. For my purposes, I have no need to bring in these speculations and will stick to what is already well established."*

Post by "Godfrey" of February 14, 2020 at 7:22 PM

Rather than attempt to outline the book or try to present any specific theories of physics, I'd like to attempt to relate current thinking as I understand it from this book to the Twelve Fundamentals of Nature in order to provide a platform for further discussion. Any mistakes are purely mine; I'm trying to figure this out as I go! If discussion follows, this might best be moved to the various forum threads under The Fundamentals of Nature; I'm listing them here to have them in one place for clarity.

Twelve Fundamentals of Nature:

1. Matter is uncreatable.

In the 18th century, Antoine Lavoisier determined the law of conservation of mass. Einstein showed that this must be incorporated into the First Law of Thermodynamics (Law of Conservation of Energy), which states that energy cannot be created or destroyed in an isolated system. This is because mass can be created and destroyed by energy. If I understand it correctly, E=mc2 defines matter as a relationship of mass and energy. Thus matter is uncreatable.

However, cosmologically, there seems to be some disagreement as to whether the universe came from nothing, as Stenger discusses in the following.

From Chapter 6, Light and the Aether: ***"...****the validity of the three great conservation laws of physics is testimony to a universe that is isolated from anything on the outside and looks just like it should look if it came from nothing."*

From Chapter 12, Atoms and the Cosmos: *"...as shown in 1970 by Stephen Hawking and Roger Penrose, Einstein's general theory of relativity implies that the universe at its first moment of existence was a singularity, that is, an infinitesimal point in space of infinite energy density. This meant that not only was matter created at that moment, but so were space and time....*

"A finite, created universe conflicts with the teachings of the atomists that the universe is eternal and boundless. In chapter 1, Epicurus was quoted as saying, "The universe is without limit." The big bang seemed to refute atheist atomism.

"However, there was a fly in the ointment. General relativity is not a quantum theory and so does not apply to a region of space less than 1.616 × 10–35 meter in diameter, called the Planck length, named for the physicist Max Planck who... initiated the quantum revolution. Applying the Heisenberg uncertainty principle of quantum mechanics, it can be shown that it is fundamentally impossible to define a smaller distance or to make any measurements inside a region of that size. Basically, we can have no information about what is inside a sphere with a diameter equal to the Planck length. It is a region of maximal chaos.

"The uncertainty principle also mandates that no time interval shorter than 5.391 × 10–43 second, called the Planck time, can be measured. Thus, our cosmological equations, derived

from general relativity, can apply only for times greater than the Planck time and only for distances greater than the Planck length. Although their singularity proof was correct for the assumptions made, both Hawking and Penrose long ago agreed that it does not apply once quantum mechanics was taken into account, a fact most theologians... have conveniently ignored. In short, the origin of our universe was not a singularity and need not have been the beginning of time."

I understand this as meaning that the Big Bang is actually the point where our physics ends, and any theories as to the initial moment are purely speculation.

Also from Chapter 12: "*In one scenario, which I have discussed in previous books and has been worked out mathematically, our universe appears from an earlier one by a process known as quantum tunneling. For our purposes here, suffice it to say that nothing in our current knowledge of physics and cosmology requires us to conclude that the beginning of our universe was the beginning of space, time, and everything else that is."*

Further: "....*while the big bang was the beginning of our universe, it was not necessarily the beginning of all that is. Modern inflationary cosmology strongly suggests that other universes besides our own exist in what is called the multiverse. Because we have no observational evidence (yet) for other universes, I will not indulge in speculations about them, except to say that such speculations are based on well-established science and their ultimate empirical confirmation is not out of the realm of possibility. In any case, allow me to simply use the term multiverse to refer to all that is, even of it should turn out that our universe is all there is."*

And: "*So the real issue is not where our particular universe came from but where the multiverse came from. This question has an easy answer. ...the multiverse is most likely eternal. Repeating myself, since it always was, it didn't have to come from anything."* This, to me, is speculation and just kicks the problem down the road. But I must confess my ignorance.

2. Matter is indestructible.

As in Fundamental 1, this is stated by the First Law of Thermodynamics.

3. The universe consists of solid bodies and void.

This invalidates the aether, the idea that the void is a medium of some sort in which things move. The wave motion of light was thought to be evidence of this ancient idea. However light was determined to be part of the electromagnetic field, a field being "a quantity that has a value, or set of values, for each point in space." Further, light was determined to be particulate, composed of photons: little bundles of energy which are bits of matter. Therefore light consists of particles in a field, not waves moving in the aether.

4. Solid bodies are either compounds or simple.

Not much to say here: atoms combine to make molecules, etc.

5. The multitude of atoms is infinite.

This is a cosmological question; I'm not aware of the theory. However if the universe is infinite, this would seem to follow.

6. The void is infinite in extent.

This is a cosmological question; I'm not aware of the theory.

7. The atoms are always in motion.

Matter is comprised of energy, mass and momentum, which I think implies motion.

8. The speed of atomic motion is uniform.

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9. Motion is linear in space, vibratory in compounds.

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10. Atoms are capable of swerving slightly at any point in space or time.

The idea of atoms traveling uniformly downward is outdated. In terms of the swerve permitting free will, I think that the reducibility of the atomic model supercedes this.

11. Atoms are characterized by three qualities, weight, shape and size.

My understanding of current theory is: particles are characterized by three qualities, energy, mass and momentum.

12. The number of the different shapes is not infinite, merely innumerable.

Regarding molecules, this still applies. Atoms are numbered in the periodic table of the elements, although I assume that may be added to, particularly in other regions of an infinite universe. Atoms, for a layman such as myself, consist of smaller particles: protons, neutrons and electrons. A simplified version of the latest model consists of up and down quarks (composing protons and neutrons), electrons, and photons.

This is my very humble attempt to grapple with these issues. Any clarification from those more knowledgeable among us would be greatly appreciated!

Post by "Cassius" of February 14, 2020 at 8:58 PM

Wow that is GREAT work Godfrey! Thank you!!! I am rusty on all this and haven't had time to read the book myself but this confirms for me that I must find the time to do that.

Post by “Godfrey” of February 20, 2020 at 8:24 PM

Being somewhat unsatisfied regarding the cosmological questions, I just finished reading **The Dancing Universe: From Creation Myths to the Big Bang, by Marcelo Gleiser**. I found it to be an excellent complement to God and the Atom.

Where God and the Atom deals with, yes, atomism, The Dancing Universe deals with, well, the universe. The book begins by categorizing various types of creation myths, then proceeds through the history of physics through the Big Bang. Where Stenger is an experimental physicist, Gleiser is a theoretical physicist. Where Stenger provides equations, Gleiser provides concepts and thought experiments (and the book is much more pleasurable to read, for me as a non-scientist). Where Stenger highlights the opposition between atomists and anti-atomists, Gleiser explores the religious motivations of various scientists and how the results of their experiments often conflicted with their beliefs. Stenger states his view on the universe fairly briefly and more or less definitively (he’s written other books on the subject, which I’ve not read). Gleiser ends the book with the state of current thinking (the book was written in 1997) having shown the crooked path leading up to this point and thereby implying a continuing crooked path. Where Stenger features Epicurus prominently, Gleiser barely mentions him.

Despite that last point, I came away from the book with a greatly renewed appreciation of Epicurus’ contribution. Not that I didn’t appreciate his ideas before reading this, but somehow the process of walking through this history of thought (conceptually, without equations ) really dialed me in to the subject. It also prompted me to recall the time spent a couple of summers ago reading the Stoics in my hammock and grappling hopelessly with the big questions, not knowing at the time that somebody by the name of Epicurus had set us on the path to understanding so long ago. What a journey it’s been!

Speaking as a layman, I recommend either or both of these two books to anyone looking to modernize their understanding of Epicurean physics. It’s a challenge, but quite rewarding.

Post by “Cassius” of February 21, 2020 at 1:49 AM

Godfrey can you summarize Gleiser's conclusion as to whether the universe is at bottom eternal in time?

Post by “Godfrey” of February 21, 2020 at 2:55 PM

Excellent question. Basically his point in the book is that we don't know, but that there are various mathematical models which fall into a limited number of categories. To the question of "is there a beginning" he provides the following five categories:

1) Yes. Creation from something.

2) Yes. Creation from nothing.

3) Yes. Order out of chaos.

4) No. Eternal existence.

5) No. Rhythmic universe.

From the book's final chapter, "Beginnings:"

"*Two of the open 'origins' questions that are particularly interesting to me are the origin of matter, that is, where did the matter we and everything else are made of come from, and the origin of the Universe as a whole. Although these are two 'origins' questions, they are quite different. While we can try to answer the question of the origin of all matter using well-established (well, almost well-established) ideas in physics, the question of the origin of the Universe as a whole is much more complicated. Even though it is possible to use general relativity and quantum mechanics to build mathematical models that exhibit a self-consistent picture of a possible beginning, models are simply not enough to understand the question of the origin of the Universe. Since all these models assume the laws of physics to be valid as a tool to forge a possible beginning, they cannot possibly explain where the laws of physics themselves came from. If we simply say that the laws of physics were created with the Universe, we fall into an endless regression.*

"*...it is the question of the origin of the laws of physics that truly deals with 'the Beginning.' And the answer to this question is beyond the scope of physical theories, at least as they are formulated at present.*"

My dissatisfaction with Stenger stating that the universe is eternal is that it read to me as an opinion, albeit one formed through a life of study (I emphasize that I only have read his book on

atomism and not his other books which may deal more directly with this). What I found so compelling about Gleiser's book is that he doesn't provide an answer but provides tools (other than equations) with which to think about the issue.

Although he doesn't say "Epicurus was right!" (Stenger basically does), after reading this book I've come away with more respect for Epicurus. Understanding how he laid the foundation for so much that followed makes his achievement even more impressive. And his assertion that nothing comes from nothing hasn't been proven wrong.

Post by “Cassius” of February 21, 2020 at 6:20 PM

Very interesting. It will take someone a lot smarter than me to unwind all this, and I hope others will do so in the future. But given that summary I would expect Epicurus a position something like the following:

If Gleiser's conclusion motivates people to say

(1) "i don't know whether the universe popped into existence from nothing," rather than

(2) "the 'best' evidence of the senses is that nothing comes from nothing, I have to live by my senses, and I am going to take as persuasive that the universe as a whole is eternal because nothing comes from nothing."

.... then probably Epicurus would, and probably explicitly did in the form it existed in his day, hold that Geiser's theories would be logically invalid. I would expect him to see them as unverifiable though sensory evidence, and contradictory to the readily available evidence that everything we see around us comes from something else, and thus that Glieser's position is damaging to the confidence of virtually all humans in their ability to live happily, and thus not a position to be encouraged.

Ultimately I think that's where this debate ends up. No matter how elaborate the theory, there is not going to be satisfactory "proof" of an answer indicating that it is not eternal, while substantial evidence for eternality is within the grasp of every ordinary human being. Some people may legitimately prefer to go through life holding "i don't know" because it gives them pleasure to contemplate "unanswerable" questions. I think we have plenty of evidence that there are many such people.

But "ordinary" people in order to have confidence in their place in the universe and their decisions on how to live want to choose from what appears to them to be the most persuasive of the possibly valid options, and I would think that Epicurus would and did encourage them not

to undermine their worldview by pursuing logical constructs that contradict readily available evidence that may not be as complete as we would like (we haven't lived forever to see it) but which is totally consistent for the duration of our own ability to reliably observe.

I would expect Epicurus to argue that his position is both (1) the most logically sound, if we properly apply reasonable rules of evidence to what is allowable in the debate, and (2) the most consistent with the goal of living happily, which requires that we not believe in supernatural / arbitrary theories absent the most compelling of evidence in their favor. And he would not admit that choice (2) amounts to choosing happiness over "truth" because he would argue that the logical arguments in favor of taking the "I don't know" position about the ultimate question are unsound.

Godfrey as you can probably tell I am just summarizing more my general conclusions about this subject to date more than anything else. I really appreciate your taking the time to read and summarize those two books!

Post by “Godfrey” of February 21, 2020 at 9:45 PM

Cassius, I was thinking after I posted that you might make points such as these  , and I agree with what you're saying. I read the book as an Epicurean, and for me it provides an interesting basis from which to go back and review Lucretius and the letters of Epicurus. I expect to have a richer understanding afterwards.

A committed Christian, Muslim, spiritualist or the like might find a "god of the gaps" in there, although Gleiser does explicitly reject that position as anti-scientific. The reason I like this book is that it gives a pretty clear description of the various theories over time: the thinking that went into them and the experimental verification. As for his conclusion (which I probably don't present very well), I think he's just describing the state of science today. I read the book to find out just that, so on that level it was just what I was looking for. I gather from the two books that one physicist today may say "the Big Bang means that everything came from nothing" where another (Stenger, for one) may say "not at all, the Big Bang was the result of a quantum tunnel from another universe." Gleiser actually gives a nice presentation of one recent physicist's desire to prove an eternal, unchanging universe and how that was discounted by the expansion of the universe. But it wasn't entirely discounted, which leaves open various possibilities.... In other words, there's a ton of nuance in the physics, and getting some understanding of that is what I enjoyed.

But I ramble. I'm with you in hoping that somebody who has seriously studied this subject unpacks this at some point!

Post by “Cassius” of February 22, 2020 at 2:34 AM

> Quote from Godfrey
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> But I ramble. I'm with you in hoping that somebody who has seriously studied this subject unpacks this at some point!

As for who that person might be, I am not sure that it will necessarily be someone who spends a lifetime studying physics.

I was thinking about this again tonight and it seems to me that we have to think about what kind of proof would be required for us to say that the questions is really settled. Given our human nature would/will/should we ever accept anything less on **any** question other than "I know because I was there and I saw/experienced it for myself" from someone we deem to be trustworthy?

Which, if so, is obviously never going to happen in astronomy, or in issues like what happened XXX number of billion years ago. We can't even really gain a lot of confidence nowadays about many aspects of what happened 50 years ago, and you could lower the number of years to a lot less than that.

So given the difficulties and the inherent limitations of our lack of personal experience, we probably do have to start with issues of "epistemology." That's an area which we don't have nearly the amount of Epicurean texts that once existed, and which we need to reconstruct to the best of our ability based on what's left and probably a thorough analysis of the method of thinking presented in Lucretius.

Which leads me back to confirming my personal opinion that I really don't want to get too strung out taking specific positions on what physics theories or theorists might be persuasive prospects or dead ends before we really have a good statement of the level and type of proof - the rules of evidence - that we should bring to the entire discussion. Getting too wrapped up in details before addressing that bigger picture probably just leads to endless dispute and even hard feelings, neither of which help anything and leave us worse off than when we started.

But that leaves us back with the question of what to do in the meantime, and back to such basic issues as "trusting the senses" and what to do and how to think in the absence of evidence that is conflicting and/or simply not sufficient. And there are good Epicurean texts that need to be brought to bear on those questions, including:

22. We must consider both the real purpose, and all the evidence of direct perception, to which we always refer the conclusions of opinion; otherwise, all will be full of doubt and confusion.

23. If you fight against all sensations, you will have no standard by which to judge even those of them which you say are false.

24. If you reject any single sensation, and fail to distinguish between the conclusion of opinion, as to the appearance awaiting confirmation, and that which is actually given by the sensation or feeling, or each intuitive apprehension of the mind, you will confound all other sensations, as well, with the same groundless opinion, so that you will reject every standard of judgment. And if among the mental images created by your opinion you affirm both that which awaits confirmation, and that which does not, you will not escape error, since you will have preserved the whole cause of doubt in every judgment between what is right and what is wrong.

25. If on each occasion, instead of referring your actions to the end of nature, you turn to some other, nearer, standard, when you are making a choice or an avoidance, your actions will not be consistent with your principles.