String theory—causing a disturbance of cosmic proportions

A review of
The Cosmic Landscape by Leonard Susskind,
Little, Brown and Company, New York, 2006

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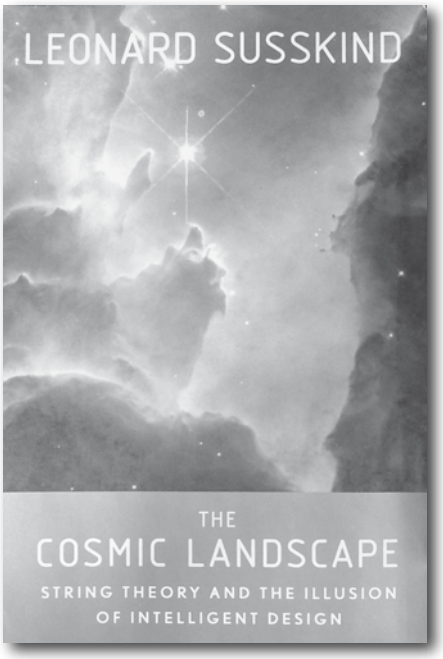


In this recently published book, Leonard Susskind, professor in theoretical physics at Stanford University, picks up where one's physics education may have left off. He gets the reader up to speed on the latest understanding of particle physics and quantum field theory, but without the equations.

In fact, the author promises early in the book that he will not use equations in his explanations—and he keeps his promise. He does make fine use, however, of Feynman diagrams. Susskind also gives engaging explanations on topics including particle physics, the Higgs field, the geometry of space, and the Holographic Principle in black hole complementarity, just to name a few. Susskind's forté as a communicator is his colourful analogies, which he employs often in an enlightening and humorous way. He even waxes philosophical as he discusses the concepts of beauty and elegance in the laws that describe nature.

Dr Susskind's stated subject of the book, however, is *why* the Laws of Physics are, not *what* they are (p. 22). Widely recognized as the father of string theory (ST), Susskind explains that a conceptual war is going on between two factions in science. He wants his reader to understand the struggle of ideas between those who believe that all the laws of nature can be determined by mathematical relations and those who believe that the laws of physics are determined, in some way, by the requirement that intelligent life be possible. The first viewpoint explains life as having emerged by chance as the fortunate by-product of the laws of physics, mathematics and probability. The second viewpoint has been termed the *anthropic principle* (AP) (p. 7). Until recently, the AP has been loathed by most evolutionary scientists because of its religious implications or because, to them, it represents a surrender of the noble quest for 'rational' answers. In fact, Susskind asserts that physicists had hoped that ST would be an alternative to the AP (this should be a lesson to those like Hugh Ross who want to claim ST is predicted by the Bible[1]).

Forced to accept the anthropic principle

But ST has failed to explain all the properties of nature in a unique way. In other words, it has failed to be the much-sought-after 'theory of everything'—and indeed even Stephen Hawking has finally realized that finding a theory of everything is a logical impossibility thanks to Gödel's incompleteness proof.[2] If ST is found to be wrong, Susskind says, '… we would be left with no other rational explanation for the illusion of a designed universe' (p. 355). Theoretical physicists have thus found themselves in the embarrassing position of having fallen into the 'waiting arms of the enemy' (p. 14), namely those who espouse the AP.

Have you ever been forced by your circumstances to begin seeing your enemy as your friend? This type of phenomenon can happen in a hostage situation. Psychologists call it the *Stockholm Syndrome*, and explain that this is an act of self-preservation which comes out of the defense mechanism of identification. Because the enemy is not going to go away, due to his superior power, the hostage begins to sympathize with his captors in order to maximize his probability of survival. It seems that Leonard Susskind has likewise been forced to embrace the AP enemy because of its undeniable explanatory strength and for his own survival as an objective scientist.

Do not mistakenly assume, however, that Susskind now believes in the benevolent creator that the AP apparently points to. No, indeed, to him the AP's religious sound is muted by a combination of inflationary cosmology and the Landscape of ST. He coined the term *landscape* in 2003 to denote a mathematical space representing all the possible vacuums (by a 'vacuum' physicists mean an environment with a particular set of physical laws, elementary particles, and constants of nature) that String Theory allows (p. 20). As Susskind says in the following quote from his introduction, explaining the struggle of ideas surrounding the AP is the subject of this new book:

> 'This book is about the emerging physical paradigm that does make use of the Anthropic Principle but in a way that offers a wholly scientific explanation of the apparent benevolence of the universe. I think of it as the physicist's Darwinism' (p. 11).

In fact, Susskind changes the meaning of the AP from being an idea that explains apparent design in the universe as evidence of a designer to being evidence for the existence of ST's fantastically varied landscape with the mechanism of eternal inflation for creating pocket universes. In other words, Susskind's version of the AP gains evolutionary science's acceptance by attempting to replace the need for a supernatural designer by the laws of very large numbers.

Two ideas are driving many evolutionary scientists to embrace the AP. First is the supposed success of inflationary cosmology and second is the acceptance of a small, but non-zero cosmological constant. Although biblical creationists reject both of these concepts, physicists recognize that each of these widely embraced interpretations requires an enormous degree of fine-tuning for intelligent life to be possible. Thus they can no longer deny that, the universe appears to have been specially designed for man. Such a thought is entirely unacceptable to Susskind who believes the whole point of science is to avoid explanations involving a God who created man with a purpose. In contrast, a creationist sees the purpose of science as being the fulfillment of mankind's Dominion Mandate given by God to subdue and have dominion over all that is in the earth (Genesis 1:28).

First we will look at how these two ideas involve a super-precision to allow for life on earth to be possible, and then we will discuss how Susskind's interpretation of ST allows physicists to willingly suppress the conspicuous 'voice' of the heavens as it unambiguously declares the glory of God (Psalm 19:1, Romans 1:18–32).

Fine-tuning in Inflation Theory

Inflation theory attempts to answer the question of how the universe could have become so homogenous that the cosmic microwave background looks the same in every direction (the 'horizon problem'). According to Alan Guth, inventor of the theory, the universe grew exponentially to immense proportions in an extremely short time before the conventional big bang is believed to have started. During this growth period, all the inhomogeneities would have gotten stretched out (p. 163). Inflation to such a large degree would leave the universe with no variations in the cosmic microwave background (CMB). However, Susskind's ideas are all moot, because the CMB actually doesn't cast the right shadows to have come from the big bang.[3]

Galaxies, on the other hand, would need variations of density in order to have formed. If the density contrasts had been too weak, galaxies would not be able to form at all; if they had been too strong, galaxies would grow too rapidly and collapse to black holes. Susskind thus believes that it now appears 'all but certain' (p. 166) that galaxies are remnants of original quantum fluctuations which every field has. Rapid inflation would stretch out the old wrinkles, but replace them with new tiny quantum wrinkles which would have accumulated to form the minute density contrasts that could eventually grow into galaxies.

Photo by NASA/JPL

Most physicists agree, the fact that galaxies full of astronomical bodies exist demands an extremely finely-tuned cosmological constant.

Inflation conceivably happened before the first light in the universe appeared, at a time beyond the surface of last scattering, a time that we can never see. These quantum wrinkles, if they existed, would have become imprinted on the surface of last scattering. Susskind interprets the tiny variations of brightness in the cosmic microwave background, mapped out by the Wilkinson Microwave Anisotropy Probe (WMAP), to be the frozen-in remnants of these pre-historic cosmic wrinkles. But he appears unaware of the severe methodological problems with this 'mapping' that would never be accepted in any other radiological field.[4]

Thus, Susskind asserts that the theory of inflation seems to have strong support from the CMB. The fine-tuning of the Inflation Theory lies in its having a suitable period for it to have occurred. Susskind believes that when our universe began, it conveniently found itself at the 'lucky spot' (p. 304) of high enough energy density to inflate at least 1020 times. Otherwise, the universe would not be big enough, smooth enough, or have density contrasts just right for our existence. He admits that arbitrarily placing the infant universe at such a fortunate place on the landscape would defeat his goal of explaining the world without an intelligent designer. But, as we shall see, with his interpretation of ST and its enormous landscape of possibilities, finding some parts of space at the lucky spot would be mathematically inevitable.

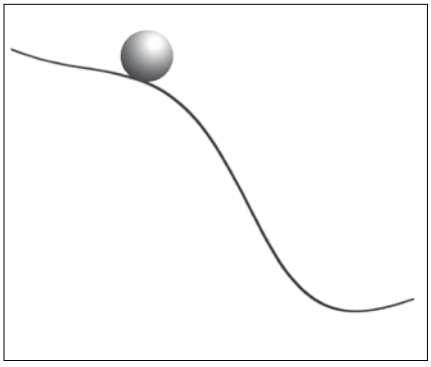
Although Dr Susskind seems to think that astronomical data have confirmed the reality of inflation, this is not the case.[5] As yet, it remains a mathematical construct, designed to rescue the big bang theory.[6]

How one interprets the CMB data is model-dependent. Gurzadyan believes that the blotches from the WMAP temperature map are not the result of lumpiness in radiation density in the early universe. Rather, they are enlarged and smeared images caused by the fact that individual photons from an original bundle follow different paths

from the source to the receiver.[7] If this interpretation of the minute variations in the CMB is correct, inflation theory loses the foundation upon which it is propped. Or if Robitaille's analysis is correct, then the maps have no cosmological significance at all.[8,4]

Fine tuning of the cosmological constant

'The mother of all physics problems' is Leonard Susskind's phrase for the problem that comes when quantum mechanics meets the Theory of Relativity. The result is a world in which astronomical bodies, as well as elementary particles, would be torn apart by the most destructive force imaginable. The only way out, as Susskind puts it, is for Einstein's famous cosmological constant to be so incredibly fine-tuned that no one could possibly think it accidental (p. 11). According to elementary particle physics, not only do the vacuum energies of fermions and bosons not cancel, but their predicted gravitational attraction is enormously too large. Since a positive cosmological constant represents a universal repulsive force, adding it into the equation counteracts the resultant vacuum energy and keeps the universe hospitable to the formation of life.



In order to attain his goal of explaining the world without an intelligent designer, the author believes our primordial universe, faced with a stupendous number of potential starting points, fortunately found itself at the 'lucky spot', a ledge of high energy density. The shallow tilt before the ledge represents the theoretical period of inflation, while the quick descent beyond the ledge is called 'reheating', a time when the potential energy was converted to heat and particles. Then the universe just happened to roll down to our present valley with its tiny anthropic cosmological constant.

Physicist Steve Weinberg theorized the anthropic upper boundary for the cosmological constant to be 10^{-120} in Planck units. He calculated that, at the time when galaxies are believed to have been formed, a cosmological constant one or two orders of magnitude larger than 10^{-120} would have enough repulsive force to overcome the tendency for gravity to cause clumping. Then the slight density contrasts thought to exist in the early universe would not have become the seeds from which galaxies, stars or planets could emerge. Professor Weinberg thus deduced that if the AP is valid, astronomers would discover the cosmological constant to be not much smaller than 10^{-120}, but not zero (p. 84). In different terms, Weinberg's anthropic argument required the effective gravitational attraction contributed by the vacuum energy to cancel the repulsive force of the cosmological constant with incredible precision, up to 119 decimal places leaving a tiny cosmological constant. Prior calculations of vacuum energy, based on theoretical particle physics only, made it 119 orders of magnitude larger than what the cosmologists got. When the empirical data from astronomical considerations confirmed Weinberg's theoretical prediction, the fallout was nothing less than a conceptual earthquake, according to Susskind. This has been said to be the most-wrong theoretical calculation ever made.

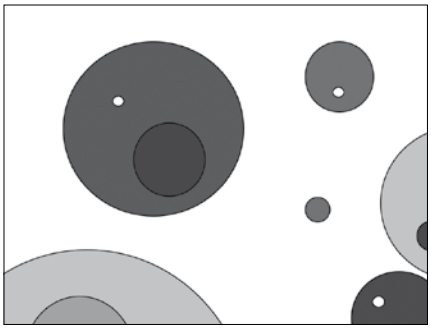
The science behind the data comes from studying Type I supernovae. Because of the unique events that lead up to a Type I supernova explosion, scientists believe they always give off the same amount of light (p. 153). Astronomers can then tell how far away one is by how bright it appears. The velocity of the galaxy containing the supernova can be determined using the Doppler method. Once the galaxy's velocity and distance are known, the Hubble constant can be determined. But since very distant galaxies presumably gave off their light in the distant past, Type I supernovae allow evolutionary scientists to deduce a great deal about the history of the universe. As always, the interpretation of these data is model-dependent.[9] Nevertheless, the results, according to Leonard Susskind, are unambiguous:

> 'The expansion of the universe is accelerating under the influence of a cosmological constant, or something very much like it. To theoretical physicists like myself, this is a stunning reversal of fortune that cannot help but change our entire outlook. For so long we were trying to explain why the vacuum energy is exactly zero. Well, it seems that it is not zero. The first 119 decimal places of the cosmological constant cancel, but then, in the 120th, incredibly, a nonzero value results. To make matters more interesting, its value is just about what Weinberg predicted it would be based on the Anthropic Principle' (p. 154).

Now physicists are faced with the apparent fine-tuning of the cosmological constant as well as supposed support from the minute variations in the cosmic microwave background that seem to support a finely-tuned Inflation theory. So how do they handle interpreting these patently providential appearances? string theory to the rescue!

String Theory has 10^{500} solutions

Physicists have lost hope in ST as an alternative to the AP because it does not pick out a unique set of physical laws for elementary particles. On account of ST's lack of defining equations or principles, Leonard Susskind has ascribed to it the following slogan: 'A Landscape of possibilities populated by a megaverse of actualities' (p. 380). There are several variables that cause ST to allow an enormous number of diverse environments, each with its own set of the Laws of Physics. The only one of these variables we will consider here is the universe's ten-dimensionality that ST predicts. The math of ST goes wrong because of the jittery quantum motion of theoretical strings unless the number of space



String theorists believe in generations of bubbles with lower vacuum energy that rarely but inevitably appear, due to quantum fluctuations, in an eternally inflating universe. Conveniently for them, these hypothetical pocket universes of the populated landscape are beyond our event horizon, and would thus be impossible to disprove.

dimensions is set at nine (plus the one time dimension) in which case the wild vibrations of different strings precisely match, causing no harm. Otherwise, the strings could violently oscillate to the ends of the universe. This stated 'miracle of the strings' would not work if some things in the world were made of point particles while other things were made of strings. Everything would need to be made of strings, or else a horrible clash would occur. This is what Susskind means when he says that ST is either a theory of everything or a theory of nothing (p. 226).

If there are really nine space dimensions to our existence, why do we only perceive three? The answer is that string theorists conveniently roll up the six extra dimensions to microscopically small size by compactification. Motion of elementary particles in the resultant new hidden directions represents different properties of the particles. These six-dimensional geometries that ST uses to compactify the extra space dimensions are called Calabi Yau spaces (p. 237). These Calabi Yau spaces are very complicated, having hundreds of donut holes through which fluxes wind. Just as the flux through any surface must always be an integer, the flux through the various donut holes in Calabi Yau space is also an integer of some flux unit. Seeing that a very large flux would stretch out the Calabi Yau space to dangerous proportions, one must not theorize putting too much flux through any one hole. For illustration's sake, we can constrain the flux integers to vary from 0 to 9. Each of these ten possible flux integers defines a potential vacuum. Each time we consider another hole, the number of possibilities grows ten times larger. Taking five hundred holes, we get 10^{500} configurations, each representing an environment with its own physical laws and vacuum energy. With that many randomly chosen values for the cosmological constant, no fine-tuning is needed to overcome the incredible improbability of 119 vanishing decimals because there will be roughly 1 in 10^{120} possibilities lying within the tiny 'window of life' value for the cosmological constant (p. 291).

Concerning ST, realize that the landscape it predicts is not a real place. It is a mathematical construct with each point representing a possible environment. To Susskind, the standard model of the currently accepted quantum field theory that describes elementary particles in our world is merely one point in the landscape of possibilities (p. 91).

String theory then has 10^{500} solutions, but it can explain nothing about our universe unless there is a mechanism that can make those possible worlds into real worlds. Some physicists believe in a vacuum selection principle that would single out our unique point in the landscape as the only viable one. Susskind suspects this vacuum selection principle does not exist because the mathematics of ST has gone toward greater nonuniqueness (p. 293).

Eternal inflation theoretically populates the landscape

The alternative to the vacuum selection principle is the populated landscape which affirms there is a natural mechanism that would have populated a megaverse with all possibilities. This hypothetical mechanism is called eternal inflation. It can be understood as a result of the metastability of the vacuum and the principle that space clones itself (p. 294). The idea is that the original universe, beginning with an initial high energy density, metaphorically 'rolled' to a valley of lower potential energy where it sits and inflates forever. Just as in the thermal metastability of super-cooled water, ice crystals can randomly nucleate and grow, so in the quantum metastability of the inflating vacuum, bubbles of new volumes of space with lower energy densities can appear and grow. Because the space inside the new bubble also inflates, next-generation bubbles can form. In fact, Susskind hypothesizes that the population of new bubble-nucleated vacuums increases exponentially until every point on the landscape is filled with pocket universes, making the landscape of possibilities into a megaverse of realities. Just as Darwinian evolution proposes the mechanisms of mutation and natural selection in its attempt to explain the intricacies of life without a designer, so ST proposes the mechanism of eternal inflation and the resultant populated landscape as the only way to explain the amazing fine-tunings of nature without God.

The author considers objections to string theory

One good aspect of Leonard Susskind's writing style is that he confronts several objections to String Theory head-on. String Theory is a very complex mathematical theory with very many possibilities for internal inconsistency. According to Susskind, all the parts fit together as a consequence of mathematical 'miracles' (p. 124). Some of his colleagues' faith in such miracles is wavering, though. He points out the reticence of Tom Banks to get on board the megaverse train. Being an experienced and respected string theorist himself, Dr Banks feels that the math involved in ST and eternal inflation may be incomplete and even wrong. He argues that the Landscape of metastable vacuums thus may be an illusion (p. 351). Perhaps not all ST's have gotten giddy by contemplating an endless expanse of nucleating bubble universes.

One particularly strong objection about ST bubbles up when one considers that the new universes created by bubble-nucleation events in an eternally inflating universe would move beyond each other's cosmic event horizons. When objects cross this boundary predicted by the theory of General Relativity, we can never have any knowledge of them: 'Some philosophers would argue that they are metaphysical constructions that have no more business in a scientific theory than the concepts of heaven, hell, and purgatory' (p. 300). But Susskind rejects this skeptical view because it does not allow him to use the power of explanation that a vast and diverse megaverse of pocket universes allows: 'The existence of other pocket universes remains, and will remain, a conjecture, but a conjecture with explanatory power' (p. 348). To put it bluntly, without the populated Landscape, he would not be able to get rid of the anthropic fine-tuning of our universe which points to a benevolent designer. I think it the height of irony that Susskind accuses creationists of believing in fairy tales when he himself uses scientific semantics to justify his faith in a never-neverland of pocket universes.

The author's objectivity ends with Intelligent Design

If Leonard Susskind gives a fair treatment of several criticisms of ST, his balanced objectivity ends when he deals with intelligent design, and his opinion even turns into uninformed bigotry when he refers to creation scientists. To Susskind, the idea of an intelligent designer is an intellectually unsatisfying myth. He calls intelligent design an illusion that substitutes rational explanation for magic. 'Creation-science' fares even worse in Susskind's opinion, as he facetiously contrasts it with 'science-science', stating that the former is not real science (p. 194), but a threatening and antiscientific idea (p. 84). As for biblical creationists, Susskind contrasts them with thoughtful and intelligent people. Rather, they are religious folk whose insecurities about being a mere vehicle for their selfish genes have been excited by evolution (p. 33). And how do these poor creationist souls find themselves so bereft of rational objectivity? Susskind explains that it is because they lack the moral fiber to resist succumbing to the human need to be comforted, which clouds their judgment. Thus they fall into the temptation of clinging to explanations that include God (p. 355). Pardon my clouded judgment, but when a scientist tries in manifest desperation to make God irrelevant by imagining an incomprehensibly large number of pocket universes in order to suggest that infinitesimally probable events are possible, I question his objectivity.

Not only does Dr Susskind malign creationists' intelligence and scientific credentials, but he also misrepresents their beliefs. Knowingly or unknowingly, he mistakenly states that creationists believe the world was created 6,000 years ago with all geologic formations, isotope abundances and dinosaur bones in place (p. 194). On the contrary, creationists' young-earth/global flood models for scientifically explaining rapidly-laid geologic formations, discrepancies in radio-isotope dating and blood found in dinosaur bones fit the evidences and make better predictions than evolutionary models. To imply that creationists believe God just put those evidences in the record to give false appearances is silly and slanderous. Thus Susskind builds up a straw man to tear it down with ridicule.

Faced with a choice: believe in God or in the populated Landscape of string theory

In his book, *The Cosmic Landscape*, Leonard Susskind goes to great length explaining that the meaning of the AP he now advocates is not that the apparent design in the universe is evidence of a designer, but that the apparent design points to his belief that, with the 10^{500} possible vacuums of ST, the existence of our hospitable universe lies within probability, despite its extreme rarity. As Stephan Hawking puts it, '... the Anthropic Principle is essential, if one is to pick out a solution to represent our universe, from the whole zoo of solutions allowed by M theory' (p. 353) [M theory is a morphed form of String Theory]. Physicists have seen the AP as the enemy because it threatens their paradigm that says everything about nature can be explained by mathematics alone (p. 187). But the widely accepted non-zero smallness of the cosmological constant is, as Susskind puts it, '... a cataclysm for physicists, and the only way that we know how to make sense of it is through the reviled and despised Anthropic Principle' (p. 22). Susskind is a desperate man—desperate to explain away the obvious handiwork of God in his firmament (Ps. 19:1). But when one's science involves impossibly large numbers, he can dream up a theory whose improbability becomes inconsequential—a world in which anything is possible, given enough time. To the objection that he has just substituted one impossible problem for another, Susskind answers that no longer having to wonder why the cosmological constant appears to be so precisely fine-tuned is preferable to worrying about the absurdity of a landscape so prodigious that one can find whatever he is looking for (p. 292).

Susskind opens and closes his book with a quote from Pièrre Simon de Laplace. When Napoleon asked him why his celestial mechanics had no mention of God, Laplace replied, 'Your Highness, I have no need of this hypothesis.' Susskind works very hard in his book to try to show why physics does not need the God hypothesis, even in light of the common scientific interpretations that undeniably point to His design in creation. In so doing, the author vainly imagines that the 10^{500} solutions that ST allows are real worlds. To him, our home is one of the very rare universes that had all the laws of physics conducive to the formation of intelligent life by evolution. Susskind's ST is similar to Darwinian evolution in that both worship at the altar of luck waiting patiently (for billions and billions of years) for the god of chance to pour forth its blessings. Romans 1:20–23

says that when people reject the glory of God manifest in His Creation, their foolish hearts are darkened, and professing themselves to be wise, they become fools. Without realizing it, Leonard Susskind has proven this passage of Scripture by espousing the populated landscape interpretation of ST.

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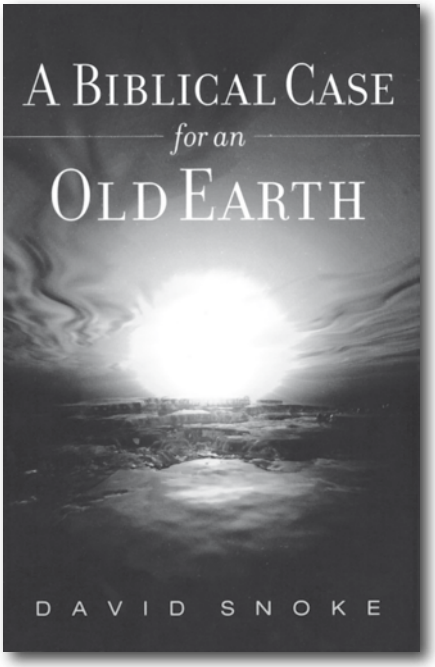
A pathetic case for an old earth

A review of
A Biblical Case for an Old Earth
by David Snoke
Baker Books,
Grand Rapids, MI



Lita Cosner

Books claiming that science disproves 'young-earth' creationism are very common, and books that claim the Bible itself does not mandate a literal interpretation of the first few chapters of Genesis are not in short supply either. David Snoke's book *A Biblical Case for an Old Earth* ostensibly falls in the latter group, though his main reason for rejecting biblical creation is really uniformitarian 'science'. Books like these generally don't pose a threat to informed creationists, and this one is no exception. In fact, Snoke could have saved himself a lot of trouble if he had actually taken the time to read more creationist literature; most of the things he cites as problems for creationists have been answered years ago.

First, some clear flaws in the book must be pointed out. It takes an amazing amount of arrogance to think that someone can refute young-earth creationism in any kind of detail in a book less than 200 pages long, and with just over 4 pages of endnotes which cite only half a dozen actual creationist works. The only creationist book he cites is *The Genesis Flood*, which is over 45 years old. No mention of *Refuting Compromise* for example that refutes almost all his arguments.[1] And the most up-to-date creationist article cited is from 1993. Clearly this is a man at the cutting edge!

Incompetent arrogance

He frequently makes assertions outside his area of expertise without citing sources, most notably regarding the Hebrew language and biblical exegesis. If the only places he used sources are where he cited them, he must have an enviable range of expertise outside of his degree in physics, indeed.

Snoke admits in the first chapter that he 'never would have come up with the view that the earth is millions of years old if [he] had never studied science' (p. 11), and though he claims to be making a 'biblical' case for an old earth, he presents the scientific case before the biblical case!

Throughout the book, he smears young-earth creationists, depicting them as people who 'latch on to people with dubious credentials who tell us what we want to hear' (p. 23), who accuse the secular scientific establishment of conspiracy to cover up young-earth evidence (p. 31) and engage in unethical scientific practices (p. 187). He accuses young-earth creationists of

> '... dismiss[ing] any input from science, adopting a young-earth creationist view even if all science