Unfortunately, *Flat Earths and Fake Footnotes* contains at least a few fake footnotes of its own. Certain quotations are either misattributed, or wrongly cited. The most glaring instance involves a lengthy passage supposedly from Westfall, crucial to the argument at that point, which is not actually in the work identified in the footnote (pp. 52–53). Although it sounds authentic (and might be), I cannot identify the source. Some statements are also erroneous, such as the description of Goethe, Humboldt, and Haeckel as "contemporaries" (p. 262). All scholars make errors from time to time (myself included), but we should keep in mind that this is not an original work of scholarship; it is rather a popularization of conclusions reached by other scholars—and more reliable than many other popular-level works about the history of science, especially considering the complex historical ideas it relates. Readers who appreciate economy of expression may also be somewhat frustrated. Certainly, the author could have greatly reduced the number of quotations and cut some other information, without losing any real substance or nuance. A stern editorial hand would have helped. Partly for this reason, I rank this book lower than *Galileo Goes to Jail and Other Myths about Science and Religion* (2009), edited by Ronald L. Numbers, and *Unbelievable: 7 Myths about the History and Future of Science and Religion* (2019), by Michael Newton Keas. However, all three belong in the libraries of ASA members who want a better understanding of the conflict thesis and its fatal shortcomings.

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## Origins

**COSMIC QUERIES: StarTalk's Guide to Who We Are, How We Got Here, and Where We're Going** by Neil deGrasse Tyson and James Trefil. Washington, DC: National Geographic Society, 2021. 309 pages. Hardcover; $30.00. ISBN: 9781426221774.

Neil deGrasse Tyson is a well-known popularizer of science; the StarTalk podcast he hosted for years is both a fun and educational resource for countless science subjects. He has teamed up with James Trefil, a prolific science writer and popularizer in his own right, to produce a book trying to summarize a vast array of human discoveries about our place in the cosmos for a primarily nonscientific audience. The book attempts to mimic the style of StarTalk in using humor and even a bit of goofiness at times to keep it light.

Two observations are worth starting off with. First, the authors have attempted to summarize and simplify a huge amount of science, and no reviewer could possibly do justice by attempting to summarize their summary. There is no central thesis or question which is under debate. An overview of topics and some high points discussed below will suffice.

But secondly, and more importantly, given the full title including the subtitle, these are questions which humans have wrestled with for millennia, and especially as they engage with personal considerations of meaning, purpose, and destiny. The ancient Greek philosophers asked similar questions, and surely humankind had pondered them for millennia before that. Yet the book settles for a response with a rather casual and unfortunate scientism. The science is wonderful, but apparently the publisher thought the book would sell better by choosing a philosophical title for a purely scientific discussion.

It may be a sign of the times that the 1982 cult movie *Blade Runner* engages more directly and significantly with those title questions than this 2021 book does. Recall the scene near the end of the movie in which Deckard asks, "All he'd wanted were the same answers the rest of us want. Where did I come from? Where am I going? How long have I got?" That is an extremely important tone and context in which those subtitle questions belong! But the essential philosophical side of those questions is utterly ignored in the book, except perhaps for a few times they poke fun at common straw man views of the church (they could at least acknowledge that the Christian worldview provided a foundation for the beginning of science as we know it). For example, the authors casually dismiss important questions when they say, "The emergence of galaxies, stars, and human intelligence all followed from this event" (p. 216). Excuse us? Human intelligence did what? Followed from galaxies and stars? Like water downhill? Is there no hard problem of human consciousness? Unfortunately, obvious categories of ideas are avoided as if they do not exist. This is clearly not accidental.

The chapter "Are We Alone in the Universe?" provides a great opportunity to characterize the book. Tyson and Trefil neatly and enjoyably summarize the history of the search for extraterrestrial intelligence starting with Lowell's "canals" on Mars and proceeding through modern day SETI. The writing is light, fast-paced, and even includes a "Dad joke." They present the Drake equation, of course, and even try their hand at a calculation of the odds, ending up as most do with a range of from one to possibly millions of intelligent races in the Milky Way. But then there is the meat—or lack thereof. They mention the Fermi Paradox that asks, "If aliens exist, where are they?" But the authors do not consider the question

of why the cumulative SETI effort, after surveying over 60 million stars, has found no evidence of other intelligent races out there. The authors mention the Rare Earth hypothesis, that the odds strongly favor very few if any other intelligent races, but dismiss it with, "This scenario is popular with religions that favor Earth as God's unique and special place in the universe" (p. 208). This slap against *Rare Earth*'s authors Brownlee and Ward is made although the word "God" does not appear in their book. Indeed, many scientists who, like Brownlee and Ward, have no apparent religious motivation, have entertained the question of whether intelligent life is common or rare. For example, consider the 2021 paper published in the peer-reviewed *Astrobiology Journal* with the title "The Timing of Evolutionary Transitions Suggests Intelligent Life Is Rare" by astronomer Andrew Snyder-Beattie et al. at the University of Oxford. In a YouTube video, physicist Sabine Hossenfelder, who is herself an atheist, states that in her experience scientists who are believers are better at keeping religion out of their work than scientists who are atheists.

One more example: the last chapter discusses the subject "before the beginning," and the fine-tuning problem is brought up briefly, but according to the authors, "The multiverse saves the day" (p. 282). First, no, it doesn't. And second, that is hardly a scientific claim! Later in the chapter they comment that when the science becomes too difficult, "philosophers step in and give it a go" (p. 286). Apparently, according to Tyson and Trefil, it is nice to have those philosophers around to engage with the insignificant questions, like who we are, how we got here, and where we're going. Oh wait, that's the book's subtitle! Yet it disingenuously ignores or disparages the deeper human questions it claims to consider and settles "merely" for amazing facts and discoveries.

This is, either accidentally or on purpose, an anti-philosophy book. Despite all of the fascination with the science, this black-and-white view of the world painfully downplays the color of our genuine deepest questions. Indeed, it has been stated that scientists often make lousy philosophers. Very bright minds can make indefensible statements, as when Stephen Hawking wrote "philosophy is dead," oblivious to the fact that this was a philosophical statement.

Ah well, enough on that theme for now. The science in the book is quite fascinating. A more appropriate subtitle for the overall work would be, "What can science alone tell us about ourselves and our universe?" But that probably would not sell the same.

The book begins with Newton and Aristotle watching an object fall, and discusses how the two would see it differently, tracing some of the history of scientific views of Earth and the cosmos. It is good to see the authors point out that the Greeks, as far back as the third century BC, knew that the world was round. Eratosthenes measured the length of the shadow of an obelisk in Alexandria at the same time the sun touched the bottom of a well in Syene, and he calculated from the angle of the shadow and the distance between the cities the size of the Earth. The authors here introduce the "distance ladder," how observations on a smaller scale can then be used to estimate much larger things. They use this several times to explain how we know some of what we think we know, especially about the size of our universe. This is well done.

After a history of views of our physical placement in the cosmos follows the history of tools of discovery—from telescopes, through radio waves, and reaching above our atmosphere to access the full electromagnetic spectrum.

Next, they look at our universe in the macro, along with its age and materials, leading to stars, planets, and solar systems, including, of course, our own. Further detail about the beginning follows, including the Cosmic Microwave Background (CMB), Inflation, and so-called Dark Energy and Matter.

After a look at chemistry for elements, particles, and quarks, and also a look at life and biochemistry, they turn to the very beginning and end of the universe, and conclude with a brief but unsatisfying chapter that explores before the beginning.

On the positive side, the book is a good basic primer to the science behind our universe. It will leave any serious student of science, professional or not, unsatisfied. Very few new ideas are presented, breadth over depth is preferred, and controversial views are omitted or minimized.

In the end, *Cosmic Queries* is an easy read and might be fine for a person just becoming interested in science and the universe, such as perhaps a high school student or a person with little or no science background. Some disclaimers are warranted regarding the utter lack of engagement in the philosophical side of the questions in the subtitle. At least the science is solid. However, a person even somewhat well read in science will find little new or exciting in it. If you need a gift for that well-read person, or if that describes you, the reviewers suggest you pick up the richer and more nuanced *Welcome to the Universe*

(2016) which Tyson cowrote with Richard Gott and Michael Strauss.

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**EVERY LIFE IS ON FIRE: How Thermodynamics Explains the Origins of Living Things** by Jeremy England. New York: Basic Books, 2020. 272 pages. Hardcover; $28.00. ISBN: 9781541699014.

Physicist Jeremy England's unique book on the latest developments in origin-of-life research is scientifically fascinating and refreshingly devoid of the typical faith/science antipathy that plagues much work in this field. What England offers is essentially a down-to-earth primer on statistical thermodynamics which enables the nonphysicist reader to understand current developments in non-equilibrium thermodynamics, such as "dissipative adaptation," that have much to say about what life is and what needs to occur for life to start naturally (i.e., spontaneously from natural precursors).

England discusses at length the precariousness of life and the improbability of a living organism being thrown together at random, but contra the Intelligent Design (ID) movement, he takes this as evidence not of its impossibility but, rather, that non-equilibrium thermodynamics must be involved in any scientific explanation. England directly addresses ID only once in a footnote:

> … of course, whenever we do not yet understand something, we always have the option of throwing up our hands and declaring that intelligent contrivance is the only way things could be this way, but we also have the option of trying harder to understand, often with a successful result … (p. 245)

Far from offering a mechanism for how life began, however, England instead examines the necessary prerequisites for what we instinctively call "life," including energy consumption, replication, and anticipating changes in the environment, and stresses that these distinctive aspects of life cannot all come from one mechanism. Through variegated collections of matter responding to flows of energy impinging on them, non-equilibrium states can be created and sustained in a manner that looks for all the world like intelligent design but can be explained by new ideas in non-equilibrium thermodynamics. The ability for an organism to live in a high-energy, non-equilibrium state without being consumed by the "fire" of energy surrounding it is not necessarily related to an organism's ability to reproduce, and neither stability nor self-replication necessarily guarantees an ability to predict environmental variables and respond to them in a self-preserving fashion. England argues that having multiple mechanisms operating and evolving in parallel for the somewhat independent qualities that constitute life makes the natural emergence of living things less improbable than hitherto imagined.

While non-equilibrium thermodynamics can help us better understand how living things may have arisen naturally from inanimate matter, the book also argues that we still need to look beyond science for why a living pile of molecules has more meaning that a pile of ashes. England, who states his personal commitment to the Jewish faith, looks to the Hebrew Bible for grounding and inspiration when wrestling with the questions of "What is life?" and "How did life begin?" He finds in the signs God gives to Moses on Mt. Horeb (Exodus 3), including his staff turning into a snake, a rich treasure-trove of wisdom regarding life, its meaning, and its intimate connection with the natural world. Thus, while the book is mostly an explication of recent insights from physics regarding what it means to be alive, it is woven together in a fascinating way with biblical wisdom gleaned from the Torah. The rich allusions and connotations England impressively draws from the Mt. Horeb signs provide another example of the deep wisdom that scripture offers in its timeless narratives.

What especially sets this book apart from other faith-based origin-of-life discussions is the fact that England himself is a leading researcher in the current science of non-equilibrium thermodynamics. He was a physics prodigy who has now established a career bridging academia and industry, and much of the book is based on his own groundbreaking work. In this regard, he carries a distinctly authoritative voice that is perhaps best compared to Francis Collins or John Polkinghorne—leading scientists whose scientific work directly overlaps the theological waters they wade into. There is some risk that the nonphysicist may feel bogged down by the detailed scientific lessons and explanations, but England does an impressive job of explaining things in everyday terms, including balls rolling down hills, springs, and snowflakes. He is also careful to include helpful summaries along the way. The accessibility of the scientific ideas and the originality of the theological reflections make Jeremy England's *Every Life Is on Fire* a must-read for anyone interested in origin-of-life issues.

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