Book Review
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When 'The End of Everything' Really Is

In something like five billion years the sun will exhaust the hydrogen gas that fuels its core and begin burning helium atoms, exerting thermal pressure on its fiery outer layers and causing a radial expansion that will push its now reddish girth beyond the orbits of the inner planets and likely engulf the Earth in an unceremonious act of mass accretion. If, somehow, humanity is still around by then, it will mean, at the very least, the literal end of the world.

If that doesn't get us, if, say, we have mastered the science of interstellar travel and colonized new worlds within the galaxy, we still won't be off the hook. Other stars will die, too, and the once vibrant galactic neighborhoods will see the lights go out, one by one, until hardly a twinkle registers across the far reaches of a nearly empty cosmos. One day far into an unimaginable future, the entire universe will meet its end in one of a handful of scenarios that cosmologists have detailed through their trademark squiggly equations; a wonderful mathematical shorthand to capture all our existential dread.

So, there it is. The universe will, in all probability, come to an end. And even if what we consider 'the universe' continues to exist, there likely won't be anything sentient around to perceive it. Researchers who study the apocalypse tend to focus on the Earth, of course. They consider the impact of the end times on humanity or, more inclusively, terrestrial life. But if the ultimate outcome is predetermined no matter what happens in the cosmological short term, what does it matter? What does that mean for us? Do we derive meaning from the impermanence of existence, or does the eventual 'end of everything' drain the meaning away from our efforts in the present?

Two recent books from the natural sciences tackle these questions head on, extrapolating the consequences of physical laws to their cold mathematical conclusions: Brian Greene's *Until the End of Time: Mind, Matter, and the Search for Meaning in an Evolving Universe* (2020) and Katie Mack's *The End of Everything* (*Astrophysically Speaking*) (2020). In these works, the end is inevitable, regardless of our ability to conceive it. For Mack, the fun comes in puzzling out the physics behind such cosmic mysteries. For Greene, it is the end of time itself that ultimately gives our existence meaning in the first place.

Though neither author addresses the concept of the apocalypse directly in the way most humanities scholars do, the end of the universe is quite literally the "end of everything" for Mack and "the end of time" for Greene. Greene even states in his introduction that "we will walk the timeline of the universe, exploring the physical principles that yield orderly structures from stars and galaxies to life and consciousness, within a universe destined for decay" (xii). As with many popular science books, Greene takes the reader on a layperson's equation-less tour of scientific history and concepts, from the laws of thermodynamics to the Big Bang, the origins of life, and human consciousness. While his primary focus is a thorough explanation of the dynamics between entropy and evolution, it's the "destined for decay" part that makes the book existentially haunting, especially with Greene's powerful argument in favor of reductionism, a determinist metaphysical perspective that brings discomfort to those who prefer the individual control of free will. Such determinism combined with our understanding of the physical sciences brings about the realization that "In the fullness of time all that lives will die" (2020, 3). He continues:

> For more than three billion years, as species simple and complex found their place in earth's hierarchy, the scythe of death has cast a persistent shadow over the flowering of life. Diversity spread as life crawled from the oceans, strode on land, and took flight in the skies. But wait long enough and the ledger of birth and death, with entries more numerous than stars in the galaxy, will balance with dispassionate precision. The unfolding of any given life is beyond prediction. The final fate of any given life is a foregone conclusion. (3)

The notion of reductionism leads to the conclusion that human thought is also the byproduct of physical processes—atoms and molecules whirling around in a particular pattern and structure that bring about what we perceive as consciousness—and Greene's project is to consider "whether

the evolving environmental conditions across space and time can support intelligent life indefinitely" (12). The empirical approach to this question based on the observations and measurements of physics is "not heartening," (12) as Greene writes. The language of natural science to describe this conclusion is as elegant as it is distant and unfeeling: "The end of each is driven by its own distinctive combination of physical processes, spanning quantum mechanics through general relativity, ultimately yielding a mist of particles drifting through a cold and quiet cosmos" (12).

Greene's description of what happens to the planets, the stars, the galaxy, black holes, and the universe at the longest timescales is mostly the story of how each of these things meets its end. At some point, "galaxies will resemble the burnt-out cities of a dystopian future" (260). While his earlier works such as *The Elegant Universe* (1999) and *The Fabric of the Cosmos* (2004) were pioneering explorations of cutting-edge ideas in physics, *Until the End of Time* bears the hallmark of a more personal meditation on life and death. Coming to terms with the existential terror brought about by contemplating the temporary nature of existence leads to a more enlightened perspective that encourages a "shift from grasping for a receding future to the feeling of inhabiting a breathtaking if transient present" (15). When you accept that "the universe will play host to life and mind only temporarily" and imagine "a future bereft of stars and planets and things that think, your regard for our era can appreciate toward reverence" (15).

Reverence is not exactly the word that most people would choose to describe what it feels like to be alive at a time when constant streams of global crises, catastrophes, and threats dominate our awareness and attention. The end of the world is not a comforting thought, though Greene's conclusion that the temporary nature of existence tasks us "with the noble charge of finding our own meaning" (16) opens the door for a more hopeful counter-narrative that attempts to rise above the impulse to daily despair.

In contrast to *Until the End of Time*'s philosophical investigation of meaning in the face of a deterministic universe, Katie Mack's *The End of Everything* (*Astrophyiscally Speaking*) is more concerned with the *how* of that end. In a playful and engaging tone, Mack explores five different possible endings for the universe:

- The Big Crunch: gravity ultimately reins in the expansion of the universe and everything eventually collapses back onto itself;
- Heat Death: the expansion of the universe continues forever, and all heat-generating matter will eventually run out of energy, leading to a cold, essentially empty blackness;

- The Big Rip: rather than waiting for everything to die in the Heat Death, dark energy drastically accelerates the expansion of the universe and rips all matter apart;
- Vacuum Decay: a shift in the fundamental properties of something called the "Higgs Field" creates what Mack dubs a "bubble of quantum death" (2020, 205) in which the laws of physics no longer work properly, and this bubble expands at the speed of light to destroy everything. (This is unquestionably the coolest scenario, and the one that could theoretically happen at any moment, if it hasn't already somewhere else in the universe);
- The Big Bounce: an eternal cycle of contraction and expansion essentially resets the universe from the beginning and starts over from scratch.

Unlike Greene, Mack frequently uses the term "apocalypse" to describe her project. Yet her interests lie squarely within the realm of the scientific method; her starting point comes from the fact that "the best measurements we have are only consistent with a handful of final apocalyptic scenarios, some of which may be confirmed or ruled out by observations we're making right now. Exploring these possibilities gives us a glimpse of the workings of science at the cutting edge" (2020, 5). Before she dives too deeply into the physics involved, Mack even spends a few introductory pages contextualizing her story of the end of the universe alongside more traditional eschatology:

> Whether or not we subscribe to any particular religion or philosophy, it would be hard to deny that knowing our cosmic destiny must have some impact on how we think about our existence, or even how we live our lives. If we want to know whether what we do here ultimately matters, the first thing we ask is: how will it come out in the end? If we find the answer to that question, it leads immediately to the next: what does this mean for us now? Do we still have to take the trash out next Tuesday if the universe is going to die someday? (4)

These final questions lead Mack to conclusions similar to Greene's, and she also grounds her interest in the cosmic apocalypse in the human search for meaning: "Acknowledging an ultimate end gives us context, meaning, even hope, and allows us, paradoxically, to step back from our petty day-to-day concerns and simultaneously live more fully in the moment. Maybe this can be the meaning we seek" (7). Again, though, this is a natural science approach, and Mack wants questions "that can be answered with sci-

entific observation, mathematics, and physical evidence," placing notions of truth within the realm of results that she can "rederive mathematically" (4).

The fact that both Greene and Mack choose to view the end of everything as an existential opportunity — Mack even writes that it "can bring a kind of joy even in the face of total destruction" (13) — rather than a call to take action is a revealing difference in perspectives between those who take the long view of the cosmos and those who study the planet. That's because thinking of the apocalypse as not merely an end but as a beginning breaks down at the cosmic scale. Cosmological concepts of the apocalypse negate or nullify many of the most pressing threats to the world because the timescales involved — billions or even trillions of years — directly contradict the narratives of immanence that dominate much current apocalyptic thinking. The nuances of climate policy, nuclear threats, imperialism, populism, racism, and so on, become smoothed out by an indifferent universe. Even the decades associated with climate change are insignificant on cosmological timescales, and those seem hard enough to convince many people of their immediacy.

One major difference between the terrestrial apocalypse — on the shorter timescale anyway — and the cosmological apocalypse is the literal powerlessness involved. The laws of physics have no criminals, so the end of the Earth and the end of the universe are not crises to be avoided or calls to action but rather the emotionless consequences of cold-blooded, dispassionate calculations. There is literally nothing we can do to stop the stages of the sun's evolution that will eventually destroy the Earth or slow down the expansion of the universe. As Emily St. John Mandel writes in her novel *Sea of Tranquility* (2022), "No star burns forever. You can say 'It's the end of the world; and mean it, but what gets lost in that kind of careless usage is that the world will eventually literally end. Not 'civilization,' whatever that is, but the actual planet" (103). The best we can hope for — assuming humans still exist at that point — is a temporary escape to another planet or star system.

Incorporating the idea of an ending universe into apocalyptic discourses may inject an interesting tension into a burgeoning field of interdisciplinary scholarship. What does it mean for our understanding of the apocalypse when "the end of everything" really is? How does this knowledge relate to, or illuminate, other concepts of the apocalypse? Does the end of the universe overshadow the end of the world, or are the timescales involved so vast and unrelatable that it makes little sense to concentrate on them, even within the context of apocalyptic figures of thought?

None of these questions are really within the scope of either *Until the End of Time* or *The End of Everything*, but it isn't much of a stretch to consider how these accessible, thought-provoking books are worthy additions to any library of apocalyptic and post-apocalyptic studies. Whether thinking about the end of everything will lead to Greene's "reverence" for our current existence or Mack's "joy in the face of total destruction," bringing such ideas into dialogue with other apocalyptic discourses may challenge the dominant narratives and encourage a deeper engagement with questions about origins, endings, and everything in between.

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