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In a May 15, 1952 letter to Genia Goelz, a recent convert to Christianity, C. S. Lewis urges "If Hoyle answers your letter, then let the correspondence drop. He is not a great philosopher (and none of my scientific colleagues think much of him as a scientist)" (*Letters* 3: 192). Lewis goes on to explain that Hoyle "is strong enough to do some harm. You're not David and no one has told you to fight Goliath! You've only just enlisted. Don't go off challenging enemy champions" (Ibid.). Editor Walter Hooper's footnote to the letter explains "Sir Fred Hoyle (1915-2001) was Plumian Professor of Astronomy at Cambridge University, and the founder of the Institute of Theoretical Astronomy" (Ibid.). This hardly sounds like an "enemy champion," which begs the question of who was Fred Hoyle, what did he do to incur Lewis's apparent ire, and did his scientific colleagues really think so little of him? These are the questions I will endeavor to answer in this essay; in addition, I will also posit that, ironically, Lewis turned to Hoyle's astronomy when crafting one of his own famous works of fiction.

It is necessary to begin with an overview of the astronomy in question. Our sun is currently a middle of the road main sequence star, contently generating energy by converting hydrogen into helium in its core, as it has been doing for the past 4.6 billion years. In about 6 billion years the core will be entirely composed of helium, and the sun will begin to die. The outer layers of hydrogen will swell up and engulf the inner planets, possibly including earth. Even if its tenuous gaseous envelope does not reach our orbit, our oceans will boil, the surface of our planet will return to the molten state of its formation, and all life on our planet will be destroyed (Schroder and Smith). The sun will become a so-called red giant because, as the name implies, it will be red in color and titanic in size. Simultaneously, the core of the sun will become hotter, as it shrinks under its own gravity, until the helium

eventually reaches a temperature sufficient to begin fusing into carbon and then oxygen. Eventually the core will collapse into a dense corpse the size of the earth, creating a white dwarf, and the outer layers of gas will puff off into space, creating a so-called planetary nebula. If the sun had been born with more mass, it would have the ability to fuse oxygen into heavier elements before dying, perhaps hopscotching down the periodic table as far as iron. But no star can fuse iron, so the heaviest of stars actually explode in a supernova, and in these cosmic conflagrations all the elements heavier than iron are formed. Fred Hoyle played a seminal role in determining many of the details in what has just been explained. Although Hoyle's most famous papers on the subjects of red giants and stellar nucleosynthesis were published in 1955 and 1957, respectively (Hoyle and Schwarzschild; Burbidge et al.), and the popular level book describing the evolution of stars in minute detail, *Frontiers of Astronomy*, appeared in 1955, several years after Lewis's letter, many of the important details were already in place by 1950 (Hoyle and Lyttleton "Structure"; Hoyle "Synthesis"), and, as will be described, had been widely shared with the general public.

This relatively late date for the birth of the modern model of star formation has escaped the notice of many scholars outside of astronomy. For example, in H.G. Wells's *The Time Machine*, the narrator travels millions of years into the future to witness the death of our planet. The sun is described as a "huge, red-hot dome" that "had come to obscure nearly a tenth part of the darkling heavens" (84). This description has erroneously led many a literary critic to assume that this is a description of the sun as a dying red giant. However, it is instead a rather accurate depiction of the sun having cooled to a red *dwarf*, with the earth having spiraled into a much closer orbit, the result being the larger *apparent* size of our star. This is a reflection of the erroneous model of stellar evolution popular in the late 1800s, in which all stars are born as large hot, blue-white main sequence stars, and shrink and cool over their lives, ultimately forming a red dwarf (Eddington 106).

But after the discovery of the existence of red giants in the early 20th century and the resolution of the physics behind the tiny, ultra-dense white dwarfs about a decade afterwards, the model of stellar evolution was modified. Circa 1925 it was thought that stars collapsed from clouds of gas to form swollen red giants, further shrank to become hot main sequence stars, and then continued to shrink and cool over time, ultimately dying as a dim red dwarf before further imploding to become a white dwarf (Eddington 107).

This model is reflected the science fiction of the day, including the novels of Olaf Stapledon. In *Last and First Men* (1930) it is said that the sun would ultimately die by "shrinking to a minute, dense grain with feeble radiation… a typical 'white dwarf'" (240), while in *Star Maker* (1937) it is noted that during its youth, a star "is what human astronomers call a 'red giant'," and afterwards the star shrinks to the smaller "state in which our sun now is" (143). Both works were not only read by Lewis, but were very influential on him. For example, in a 1938 letter to Roger Lancelyn Green, Lewis explains that he was "spurred" to write *Out of the Silent Planet* by Stapledon's *Last and First Men* and geneticist J.B.S. Haldane's *Possible Worlds* (Lewis *Letters* 2: 236). We also see this model of stellar evolution (along with a nod to the ultimate heat death of the universe) in Lewis's 1944 lecture "Is Theology Poetry": "The sun will cool—all suns will cool—the whole universe will run down" (Hooper 149).

But there is another avenue of astrophysical research for which Fred Hoyle was known circa 1950, namely the so-called "Steady State" model of the universe, proposed independently by Hoyle and two fellow Cambridge scientists, Herman Bondi and Thomas Gold in 1948 as an alternative to the Big Bang model (then called the Evolutionary model). As the name implies, the Steady State posits that the universe had no beginning and remains in a permanent unchanging state (although, of course, individual stars are born and die). But the apparent motion of the galaxies away from each other (as discovered through their redshifts by Hubble and others in the 1920s) was compelling evidence, and would make the density of the universe decrease over time—unless, as the Steady State claimed, new atoms of hydrogen are spontaneously created at just the right rate to keep the density of the universe constant. This appears to violate the crucial law of conservation of matter/energy in the universe, unless some new physics is invoked.

Historian of science Helge Kragh reports that at the first public discussion of the Steady State, a December 1948 meeting of the Royal Astronomical Society, the overall response by the scientific community was "reluctant, but not unambiguously hostile" (189). This reaction was due, in part, to the fact that the idea of the spontaneous creation of matter was not original to the Steady State, and had been suggested (albeit briefly) in the unorthodox cosmological models of Oxford astrophysicist Edward Arthur Milne. But Milne voiced clear skepticism at this so-called "New Cosmology," as did many other scientists. Outside of Britain, the Steady State was barely on the

scientific radar (Kragh 223). Over the 1950s and 60s, experimental and observational evidence continued to pile up for the Big Bang and against the Steady State, although to his dying day Fred Hoyle rejected the Big Bang and continued to propose alternative explanations for the observed redshift of the galaxies (Mitton 314).

In fact, the Steady State might have died a quiet death long before Lewis's letter if it hadn't been for the BBC, who asked Hoyle (after producing controversial yet engaging talks for the network in previous years [Mitton 125-32]) to deliver a series of five 45-minute long astronomy programs on their *Third Programme* broadcast in January and February 1950. It proved so popular that a book treatment, entitled *The Nature of the Universe*, appeared to strong sales only two months later. The lectures were later rebroadcast over the summer, in a slightly different format, to an estimated audience of 3 million on the popular BBC *Home Service* broadcast (Kraugh 191).

Hoyle used his lectures as a vehicle through which to pitch both his own model of the evolution of stars—including the now correct positioning of red giants as near the end of a star's life rather than the beginning—and the Steady State. Hoyle also used the lectures to espouse his personal beliefs about extraterrestrial life. For example, in the very first lecture, he makes the bold statement (without evidence) that "I would say that rather more than a million stars in the Milky Way possess planets on which you might live without undue discomfort"(*Nature of the Universe* 21). Interestingly, there simultaneously existed three different versions of Hoyle's series. In the printed script, published not long after each initial broadcast in the magazine *The Listener*, Hoyle launches into an attack on religion, which he describes as "a blind attempt to find an escape from the truly dreadful situation in which we find ourselves. Here we are in this wholly fantastic Universe with scarcely a clue as to whether our existence has any real significance" (Mitton 134; Hoyle *Nature of the Universe* 115). Rubbing salt into the wound even further, the atheist Hoyle adds in the book version "I should like to end by discussing in a little more detail the beliefs of the Christians as I see them myself. In their anxiety to avoid the notion that death is the complete end of our existence, they suggest what is to me an equally horrible alternative. . . . [W]hat the Christians offer me is an eternity of frustration" (*Nature of the Universe* 117).

Helge Kragh opines that "Hoyle's attack on Christianity undoubtedly aroused antagonistic feelings in many people and helped to make Hoyle a controversial figure" (192). Lewis's obvious disdain

for Hoyle would have put him in excellent company at this juncture, as both scientists and theologians openly attacked Hoyle. For example, Father Daniel O'Connell, Director of the Vatican Observatory, called Hoyle "naïve" and "remarkably foolish" during a three-night-long discussion on Australian Radio (Kragh 195). No less than "honorary Inkling" Dorothy Sayers voiced her own radio critique on the BBC *Home Service*. As an invited speaker, Sayers took the opportunity to attack Hoyle's views on science and religion in general, and the Christian afterlife in particular. She admonishes that "the scientist should beware of too childlike a credulity about data: they may be literally 'data', things given—clues (or red herrings) handed out to him, to look as though he had found them" (497).

But what of Lewis's claim that Hoyle had a dubious scientific reputation overall? A review of *The Nature of the Universe* by Kirtley Mather of the Geology Department of Harvard calls Hoyle "a brilliant young Cambridge University astronomer who displays a commendable flair for presenting intricate data and mind-stretching ideas in a lucid, attractive style" but warns that the book "should be read with great caution," pointing out several topics where Hoyle "writes dogmatically" and "overreaches" (427-28). Hoyle's estimate for the number of habitable planets in the galaxy is described as being built on "a precarious inverted pyramid of speculation piled on speculation after speculation, interlarded with slippery assumptions" (Mather 428). University of Toronto astronomer Ralph Williamson notes in his review that Hoyle is "Brilliant and highly trained in mathematics and astronomy," but warns that "many scientists have severely criticized Dr. Hoyle's current series of lectures," the criticism based on "the deeper issue of the truth or falsity of the material discussed" (185–86). Hoyle's chief crime, according to Williamson, is his failure to be impartial in his "presentation of scientific fact" (186). Williamson actually takes the time to do a statistical analysis of Hoyle's claims, finding them to be "about 20 per cent. pure fact, about 30 per cent. of working hypotheses, and the remaining 50 per cent. was devoted to pure, untested theory. It will not surprise you, at this point, to hear that the theory was, almost without exception, Hoyle's own" (188). Hoyle was therefore recognized as a brilliant, if not controversial, member of the professional astronomical community, a reputation that became even more schizophrenic over the subsequent decades. For example, it is well-known that most of the groundbreaking research on the synthesis of heavier elements inside stars reported in the pioneering 1957 Burbidge et al. paper was done by Hoyle. Yet, it was William

Fowler who received the 1983 Nobel Prize for the research, not Hoyle, a decision that has led more than one author to suggest that the snub was due to Hoyle's troubled relationship with his peers (McKie).

Lewis himself publically took Hoyle to task a number of years after the radio broadcasts, specifically attacking Hoyle's unsubstantiated claims about the likelihood of extraterrestrial life, as well as Hoyle's open hostility towards Christianity. In the 1958 essay, "Will We Lose God in Outer Space" (later named "Religion and Rocketry"), Lewis reflects that when he was a child, the predominant scientific opinion was that extraterrestrial life is highly unlikely:

> Probably life was a purely terrestrial abnormality. We were alone in an infinite desert. Which just showed the absurdity of the Christian idea that there was a Creator who was interested in living creatures. But then came Professor F.B. Hoyle, the Cambridge cosmologist, and in a fortnight or so everyone I met seemed to have decided that the universe was probably quite well provided with inhabitable globes and with livestock to inhabit them. Which just showed (equally well) the absurdity of Christianity with its parochial idea that Man could be important to God. (*World's Last Night* 83)

In "Onward, Christian Spacemen" (1963), also known as "The Seeing Eye," Lewis likewise opines

> When we were boys all astronomers, so far as I know, impressed upon us the antecedent improbabilities of life in any part of the universe whatever. It was not thought unlikely that this earth was the solitary exception to a universal reign of the inorganic. Now Professor Hoyle, and many with him, say that in so vast a universe life must have occurred in times and places without number. The interesting thing is that I have heard both these estimates used as arguments against Christianity (*The Seeing Eye* 235).

Lewis's summary of the scientific establishment's view of extraterrestrial life in the early 20th century is simplistic, but not entirely incorrect. For example, in *The Universe Around Us* (1930), Sir James Jeans (whose popularized works Lewis was not only familiar with, but recommended [*Letters* 2: 1011]) writes "Apart from the certain knowledge that life exists on earth, we have no definite knowledge whatever except that, at the best, life must be limited to a tiny fraction of the universe" (331). This rather pessimistic viewpoint is largely fueled by the then current tidal model of planetary formation, which relies on a passing star to rip material out of a star in order

to form planets (Jeans 328). However, Lewis's childhood years were also the time when American amateur astronomer Percival Lowell was publishing a series of popular books claiming that there had been (and perhaps still might be) intelligent life on Mars, as the existence of the so-called Martian canals was not debunked by observational astronomers until the 1909 observing season (Crowe 509).

It is important to note that not all scientists of Lewis's generation were atheists; indeed, to the contrary, there were devout Christians within astrophysical circles, including the aforementioned Oxford astrophysicist Edward Arthur Milne. In a series of lectures written shortly before his death in September 1950 that were never publically delivered but instead published in 1952, Milne criticizes the Steady State model on theological grounds. He argues that it could not be consistent with an Almighty creator, as it relegates creation to merely the "routine production, with penny-in-the-slot regularity and monotony, of hydrogen atoms" (77). Milne also believes that that the concept of Christ having to die on the cross on an infinite number of habitable words is too horrific to contemplate; therefore it happened only once, on our world. Perhaps we were the only world who needed saving, or in the future humanity may spread the gospel to all possible fallen worlds through radio astronomy (153-54). Compare this to Lewis's statement in "Religion and Rocketry": "It may be that Redemption, starting with us, is meant to work from us and through us…. Only if we had some such function would a contact between us and such unknown races be other than a calamity" (*World's Last Night* 88). Milne was ill during the time of the rebroadcast of Hoyle's lectures, and therefore could not join the subsequent condemnation, although Hoyle biographer Simon Mitton describes Milne as "ever a stern critic of Hoyle" (125).

It is unknown to this writer what direct interactions, if any, Lewis had with either Hoyle or Milne. Given the myriad references to Milne's work, not only in scientific but more mundane circles (Kragh 64-65), it would have been nearly impossible for Lewis not to have had at least a passing knowledge of his work. In addition, the three men were in relatively close geographical proximity as academics. It is also interesting to note the timing of Lewis's public attack on Hoyle in "Will we lose God in outer space" (1958), coming in the same year that Hoyle was appointed to the prestigious Plumian Chair at Cambridge, and one year after the publication of Hoyle's commercially successful science fiction novel, *The Black Cloud*, in which a sentient cloud of interstellar gas particles threatens life on earth. At this point, Lewis

had been on the faculty of Magdalene College at Cambridge for several years, and most certainly would have had the opportunity to meet Hoyle, if he had chosen to. Similarly there had certainly been opportunities for Lewis and Milne to interact professional or socially, if Lewis had wished it, as Milne had been the Rouse Ball Professor of Mathematics at Oxford, from 1929 until his death in 1950.

Having answered the three questions posed at the start of this essay, we now explore how Lewis ultimately found himself apparently needing Hoyle (or at least his astronomy) in crafting his world of Narnia. Lewis retorted to a complaint by scientist J.B.S. Haldane about the inaccuracy of the science in the Ransom Trilogy that "I needed for my purpose just enough popular astronomy to create in 'the common reader' a 'willing suspension of disbelief'…. There is thus a great deal of scientific falsehood in my stories: some of it known to be false even by me when I wrote the books" (*Of Other Worlds* 76). It is well established that Lewis knew quite a bit of astronomy, not only about the visible night sky, but the history of astronomy (Paxford 126; Lewis *Discarded Image*). His descriptions of the surface of Venus in *Perelandra* are indeed fantastical and original, but do pay homage to scientific presumptions about the Cytherean environment circa 1940 (Dozois xii-xiv).

The astronomical references to Hoyle's work are associated with the deaths of stars in the universe of Narnia, as described in the novels *The Magician's Nephew* (1955) and *The Last Battle* (1956). Despite the fact that Roger Lancelyn Green recalls having been read part of an early draft of *The Magician's Nephew* in 1949, he did not see a completed manuscript until early 1954 (Ward 306). Therefore both novels were essentially written after the infamous radio broadcasts of Hoyle and the publication of *The Nature of the Universe* in 1950. In the first novel, readers visit the dying world of Charn, whose sun is clearly and unequivocally described as an old, dying red giant:

> Low down and near the horizon hung a great, red sun, far bigger than our sun. Digory felt at once that it was also older than ours: a sun near the end of its life, weary if looking down upon that world. . . . "Was it the Deplorable Word that made the sun like that?" asked Digory. . . . "So big, so red, so cold."
>
> "It has always been so," said Jadis. "At least, for hundreds of thousands of years. Have you a different sort of sun in your world?"
>
> "Yes, it's smaller and yellower. And it gives a good deal more heat."

> The Queen gave a long drawn "A-a-ah!. . .. yours is a younger world" (29-30).

At the end of Narnia, as depicted in *The Last Battle*, that world's sun also becomes a red giant: "Lord Digory and the Lady Polly looked at one another and gave a little nod: those two, in a different world, had once seen a dying star…. It was three times—twenty times—as big as it ought to be, and very dark red" (515).

This bloated behemoth of a sun is then squeezed out of existence into the feeble ember of a white dwarf, leaving the night sky utterly black and cold, not by gravity, but the hand of a giant. The symbolism of a giant forming a white dwarf is simply too perfect to be accidental. Given that the concept of red giants as the end points of stars was largely due to the work of Fred Hoyle in the late 1940s, and would have been all but unknown to the non-scientist save for Hoyle's infamous lectures and the resulting book, Lewis apparently either didn't think so little of Hoyle's science after all, or was pandering to his audience's fascination with and knowledge of Hoyle's lectures. He freely admitted in his response to Haldane's criticism that he didn't feel compelled to use real science, but yet, strangely, in this case, it appears he did.

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