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Cosmic Endgame: Theological Reflections on Recent Scientific Speculations on the Ultimate Fate of the Universe

This article interacts with scientific scenarios concerning the ultimate fate of the universe developed by the physicists Freeman Dyson, Frank Barrow, and John Tipler. The history of 'thermodynamic pessimism' dating from the 19th century is briefly reviewed, and it is argued that these scenarios do not succeed in escaping this pessimism. It is concluded that any ultimate hope for humanity can not be found on the basis of known laws of physics alone, but must be derived from the standpoint of divine revelation.

Keywords: Thermodynamics, heat death of universe; eschatology; Dyson; Barrow; Tipler.

'I hope with these lectures,' stated Freeman Dyson, a physicist at the Institute for Advanced Study in Princeton, New Jersey, 'to hasten the arrival of the day when eschatology, the study of the end of the universe, will be a respectable scientific discipline and not merely a branch of theology.'¹ In a seminal and far-ranging set of speculative lectures originally delivered at New York University in 1978, Dyson set out to challenge the prevailing pessimism of scientific opinion concerning the ultimate fate of the physical universe. Boldly extrapolating the known laws of physics into the most remote reaches of time, he challenged the dominant view that 'we have only the choice of being fried in a closed universe or frozen in an open one.'² Some form of intelligent 'life' – perhaps only in the form of a computer-chip like structure – might be able to continue to exist in the outer darkness and extreme coldness of an unendingly expanding universe, long after *Homo sapiens* and other forms of carbon-based life had perished from the cosmos. Making no apologies for mixing 'philosophical speculations with mathematical equations,' Dyson boldly disregarded the traditional scientific reluctance to mix scientific analysis with questions of the ultimate purpose and meaning of life.

Dyson was, in effect, issuing an invitation to faith communities to engage in a conversation that related religious understandings of the end of the universe to

1 Freeman J. Dyson, 'Time without End: Physics and Biology in an Open Universe,' *Reviews of Modern Physics* 51:3 (1979): 447–460 at 447.

2 *Ibid.*, p. 448.

the new scientific 'eschatologies.' This paper will attempt to reflect theologically on recent scientific attempts like that of Dyson's to avoid the pessimistic conclusions about the fate of the universe that have dominated the scientific community since the development of modern thermodynamics and its notion of the 'heat death' of the universe. This paper will attempt to assess the intellectual challenges and the apologetic opportunities for the church's witness in the face of these scientific 'eschatologies.'

The Rise of Modern Scientific Eschatologies:

The development of the discipline of thermodynamics in the nineteenth century gave rise to scientific speculations about the ultimate fate of the universe that have continued down to the present day. In a public lecture delivered in 1854 titled 'On the Interaction of Natural Forces,' Hermann Helmholtz, professor of physics at the University of Berlin, reflected on the implications of the Second Law of Thermodynamics for the very long-term prospects of the human race. The Second Law, which came to be recognised as one of the fundamental principles of physics, states that in any closed physical system, the amount of energy available for useful work decreases over time. Or stated another way, the amount of *entropy* or disorder in a system tends to increase over time.³ The useful energy in physical systems inevitably tends to dissipate or 'run down,' just as a clock, once wound up, will eventually run down. Helmholtz and other physicists recognised that the universe as a whole is 'running down': eventually, over the vast reaches of cosmic time, the sun and all the stars will have exhausted their fuel, and the cosmos will face the unending darkness and coldness of the 'heat death' of the universe.

According to Helmholtz, the 'inexorable laws of mechanics' indicate that the store of available energy in the universe must finally be exhausted. The Second Law of thermodynamics permits the human race '... a long but not an endless existence; it threatens us with a day of judgment, the dawn of which is still happily obscured.' Eventually, the inescapable working of the laws of physics will force the human race to perish and give way to '... new and more complete forms, as the lizards and the mammoth have given place to us.'⁴

3 For general introductions to thermodynamics and the Second Law, see Hans C. Ohanian, *Physics* (New York: W.W. Norton, 1985), pp. 520–525; George B. Arfken, David F. Griffing, Donald C. Kelly, and Joseph Priest, *University Physics* (New York: Academic Press, 1984), pp. 444–458; and C.J. Adkins, *An Introduction to Thermal Physics* (Cambridge: Cambridge University Press, 1987). For a more advanced treatment, see Mark W. Zemansky, *Heat and Thermodynamics*, 5th ed. (New York: McGraw-Hill, 1968), ch. 9, 'Entropy,' pp. 214–250. A readable discussion of thermodynamics for a general audience, with helpful insights on historical and philosophical dimensions of the subject, is provided by Martin and Inge F. Goldstein, *The Refrigerator and the Universe: Understanding the Laws of Energy* (Cambridge: Harvard University Press, 1993).

4 Hermann Helmholtz, *Popular Lectures on Scientific Subjects*, tr. E. Atkinson (London: Longmans, Green, & Co., 1884), pp. 137–171 at 170, 171. It was not widely recognised in the nineteenth century, but the Second Law implied a finite age for the universe: if the available energy was indeed running down, it could not have been running down forever. For the attempts of the British physicist William Thomson (Lord Kelvin) to use the principles of thermodynamics to calculate an absolute date for the age of the earth, see Joe D. Burchfield, *Lord Kelvin and the Age of the Earth* (Chicago: University of Chicago Press, 1975: 1990).

As the nineteenth century progressed, the pessimistic conclusions of the physicists began to influence leaders in the other scientific disciplines. Charles Darwin, for example, had, on the basis of his evolutionary views, come to expect greater perfection and progress for the human race over time. The implications of the Second Law, however, challenged this optimism in a fundamental way. For Darwin, it was an 'intolerable thought' that the human race and all sentient beings were inevitably 'doomed to complete annihilation' after long-continued ages of slow progress. In his autobiography, begun in 1876 but not first published until 1887, Darwin admitted that it seemed a scientific inevitability that 'the sun with all the planets will in time grow too cold for life.' To those who had a strong faith in the immortality of the human soul, such a prospect might not appear to be so dreadful, but he could not number himself among that company.⁵

In the earlier decades of the twentieth century the implications of thermodynamics were communicated to the general public by the British astronomers Arthur Eddington and James Jeans. In his Gifford Lectures of 1927, Eddington, professor of astronomy at Cambridge, spoke about the 'Running Down of the Universe.' 'Whoever wishes for a universe which can continue indefinitely in activity,' he stated, 'must lead a crusade against the second law of thermodynamics.' The final fate of the universe, according to Eddington, was a state of 'chaotic changelessness.' In his view such a fate, while certainly a gloomy prospect, was to be preferred to suggestions that the universe might undergo endless cycles of expansion and collapse. 'I would feel more content that the universe . . . having achieved whatever may be achieved, lapse back into chaotic changelessness, than that its purpose be banalised by continual repetition.' To Eddington it seemed ' . . . rather stupid to be doing the same thing over and over again.'⁶ It is worth noting that Eddington's discussion of the Second Law led him to address questions of meaning and *purpose* that had generally been excluded from scientific discourse by the positivistic philosophies of science of the nineteenth century.

In a series of popular lectures later published under the title *The Universe Around Us*, Sir James Jeans discussed questions of 'Beginnings and Endings' and the long-term implications of the Second Law. 'Energy cannot run downhill forever,' he noted, 'And so the universe cannot go on forever . . . the active life of the universe must cease.' In the very far distant future, the result will be ' . . . a dead, although possibly warm universe – a "heat death"'. Such is the teaching of modern thermodynamics.' In spite of this gloomy conclusion, Jeans was surprisingly optimistic about the prospects of the human race prior to the final end: ' . . . a day of almost unthinkable length stretches before us with unimaginable opportunities for accomplishment.'⁷ For this British astronomer, the ultimately pessimistic implications of thermodynamics were evidently mitigated by a

5 Nora Barlow, ed. *The Autobiography of Charles Darwin: 1809–1882* (London: Collins, 1958), p. 92.
6 A.S. Eddington, *The Nature of the Physical World* (Cambridge: Cambridge University Press, 1928), p. 86.

nearer-term optimism growing out of a faith in the powers of modern science and technology.

One of the best-known responses in this century to the gloomy message of thermodynamics was the often-quoted passage in Bertrand Russell's book, *Why I am Not a Christian*. Russell summarised the implications of modern science as he understood it for the human future in this way:

That man is the product of causes which had no prevision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and his beliefs, are but the outcome of accidental collocation of atoms; that no fire, no heroism, no intensity of thought and feeling, can preserve an individual life beyond the grave; that all the labours of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system, and the whole temple of Man's achievement must inevitably be buried beneath the debris of a universe in ruins – all these things, if not quite beyond dispute, are yet so nearly certain that no philosophy which rejects them can hope to stand . . . only on the firm foundations of unyielding despair, can the soul's habitation henceforth be safely built.

Despite this eloquent expression of scientific and philosophic despair, Russell went on to say that in practice this gloomy scenario would have little impact on the average person's everyday life. No one really worries much about the fate of the universe millions of years into the future; such considerations merely lead one to 'turn your attention to other things.'⁸ It seems for Russell that the only way that modern man can cope with the gloomy truth that human life must inevitably die out is to live in what psychologists would call a permanent state of avoidance and denial.

More recently in this century the tradition of what might be called 'thermodynamic pessimism' has been expressed in the writing of the Nobel prize winning American physicist Steven Weinberg. In his widely read book of 1977, *The First Three Minutes: a Modern View of the Origin of the Universe*, Weinberg brought to the attention of the general public modern science's attempts to apply the methods of elementary particle physics to the understanding of the universe's development in the very first minutes after the 'Big Bang.' At the end of this book Weinberg offered his personal reflections on the human meaning of the current scientific picture of the origins of the universe and its ultimate fate. It is 'almost irresistible', he noted, for human beings to believe that we have a special place in the universe, and that human life is not just some 'farcical outcome of a chain of accidents reaching back to the first three minutes.' It is not easy for human beings to come to grips with the scientific picture of an earth that is just a 'tiny part of an overwhelmingly hostile universe', and the prospect that the present

7 James Jeans, *The Universe Around Us* (Cambridge: Cambridge University Press, 1929), p. 320.

8 The passage from Russell is quoted in John D. Barrow and Frank J. Tipler, *The Anthropic Cosmological Principle* (Oxford: Clarendon Press, 1986), p. 167.

universe 'faces a future extinction of endless cold or intolerable heat.' The inevitably gloomy conclusion of this analysis, according to Weinberg, in a much-quoted statement, is that 'The more the universe seems comprehensible, the more it also seems pointless.'⁹

Weinberg's response to such a scenario differs from Bertrand Russell's strategy of avoidance and denial. There may be no comfort in the results of modern science, but perhaps man may find some solace in the process of research itself. For Weinberg, the very attempt to understand the universe lifts human life above the level of farce and meaninglessness, and 'gives it some of the grace of tragedy.'¹⁰ Human life may have no enduring purpose or meaning, but perhaps it can have the stoical dignity of an honest and scientifically informed self-awareness.

Recent Expressions of Cosmic Optimism

During the last two decades there have been several notable attempts by physicists to challenge the dominant 'thermodynamic pessimism' stemming from the nineteenth century.¹¹ The pioneering effort in this regard was the series of lectures delivered in 1978 at New York University by Freeman Dyson, already noted above. Dyson set himself the task of answering the question of whether intelligent life could continue to exist indefinitely in an 'open' universe that continued to expand and cool forever. In order to proceed with his calculations Dyson had to make a number of assumptions. He predicated an 'open' universe, that is, a universe in which the total mass of the cosmos was insufficient to halt through gravitational attraction the expansion begun at the 'Big Bang'. Dyson had already come to the conclusion that if the universe were 'closed,' that is, if the cosmic expansion would ultimately halt and the universe finally collapse upon itself in a 'Big Crunch,' then life could not exist forever. In such a case, he reluctantly conceded, 'we have no escape from frying.' No matter how far the human race might try to burrow itself into the earth to shield itself from the 'ever increasing fury' of the background radiation, we could 'only postpone by a few million years our miserable end.'¹²

Dyson also assumed (1) that the laws of physics did not change over time, and (2) that the relevant laws of physics were already adequately known. With regard to the latter assumption, Dyson was, of course, incorporating the principles of quantum mechanics and discoveries in cosmology such as the evidence for

9 Steven Weinberg, *The First Three Minutes* (London: Andre Deutsch, 1977), p. 154.

10 *Ibid.*, p. 155.

11 Dyson (1979), *op.cit.*, and Barrow and Tipler (1986), *op.cit.* These technical treatments, together with related issues, are discussed in more popular form in Jamal N. Islam, *The Ultimate Fate of the Universe* (Cambridge: Cambridge University Press, 1983); Frank Close, *End: Cosmic Catastrophe and the Fate of the Universe* (London: Simon and Schuster, 1988); Paul Davies, *The Last Three Minutes: Conjectures about the Fate of the Universe* (London: Weidenfeld & Nicolson, 1994); and Frank J. Tipler, *The Physics of Immortality* (London: Weidenfeld & Nicolson, 1994).

12 Dyson, *op.cit.*, p. 448.

the 'Big Bang' that were not known by the nineteenth-century thermodynamicists. To make such assumptions seemed reasonable enough, and without them the calculations could hardly proceed. Dyson freely admitted the highly speculative nature of his investigation, but argued that it was nevertheless intellectually worthwhile to explore the consequences of known physical laws 'as far as we can reach into the past or the future,' because such extrapolations of known laws into new territory could lead to the asking of important new questions.¹³

Dyson began his investigation by studying the physical processes that would occur in an expanding universe over very long periods of time. He concluded that in about 10^{14} years all the stars would have exhausted their hydrogen fuel and burned out, finally reaching a cold, dark state as white dwarfs, neutron stars, or black holes. After 10^{64} years black holes would have 'evaporated' by the emission of heat radiation by the Hawking process. After 10^{65} years, because of a quantum-mechanical effect known as 'barrier penetration' (or 'quantum tunneling'), the molecules in all remaining solid objects would have moved and rearranged themselves in somewhat random fashion, behaving like the molecules in a liquid, flowing into diffuse, spherical shapes under the influence of gravity. After the incredibly long period of 10^{1500} years, because of nuclear processes, all elements will have decayed or fused into iron. Finally, in the most remote imaginable future, depending on the minimum mass required to form a black hole, all matter will have disappeared into radiation, or else last forever in the form of microscopic grains of iron dust.¹⁴

Having explored the nature of physical processes far into the most remote future, Dyson then turned to the question of the continuance of intelligent life under the extremely cold and dark conditions of an ever-expanding open universe. What forms of sentient life might be able to persist long after *Homo sapiens* and other forms of carbon-based life had become extinct? Answering such a question, of course, involved making certain assumptions about the nature and definition of 'life.' For the purposes of his calculations, Dyson assumed that the basis of consciousness was not a particular type of matter but rather a particular type of complex *structure*, and that a computer or computer-like structure [such as an organised dust cloud] could be sentient and so considered 'alive.' Dyson admitted that neither of these assumptions could be known to be true given our present state of knowledge. Proceeding under these assumptions, however, he envisioned a distant future when life would have evolved away from flesh and blood and become embodied in something like a cloud, '. . . a large assemblage of dust grains carrying positive and negative charges, organising itself and communicating with itself by means of electromagnetic forces.'¹⁵

13 *Ibid.*, pp. 449, 450.

14 These results, and others, together with Dyson's detailed calculations and assumptions are found on pp. 450–453.

15 *Ibid.*, p. 454. Dyson's discussion of biological processes, from which the following citations and calculations are cited, is found on pp. 453–457. It is significant that Dyson works with a rather minimalist model of sentient life, one based on computers and information processing. Of the two

Having made these assumptions, Dyson proceeded with calculations concerning the energy requirements of such a form of life. This life-form would need to maintain an internal temperature greater than that of the universal background radiation as the universe continued to expand, and would need to continue to radiate waste heat into space. He further postulated that the life-form would adopt a strategy of 'hibernation' in order to conserve energy, with increasingly long periods of 'sleep' alternating with shorter and shorter cycles of 'wakefulness' as the universe continued to cool and expand into the outer darkness. Dyson then calculated that a life-form with a cognitive complexity equivalent to that of the present human species could maintain itself forever, needing only about as much energy as the sun radiates in eight hours.¹⁵ By using the technology of analog rather than digital computers, this life-cloud could enjoy a memory and subjective experience of 'endlessly growing capacity.' Dyson cheerfully concluded that he had demonstrated the possibility of 'a universe of life surviving forever . . . growing without limit in richness and complexity.'¹⁷

Dyson's optimistic vision of the universe's distant future contrasts sharply with the pessimism of Weinberg and the nineteenth-century thermodynamicists. Just how plausible is such a scenario? Apart from strictly quantitative considerations of energy requirements, at the level of 'quality of life' considerations the Dyson scenario would seem to leave much to be desired. He assumes that a computer or computer-like structure such as a dust cloud could be sentient; he does not discuss the question of whether such a being would also experience the emotional and affective states that we consider essential to a genuine human existence. The human brain – the most complex entity in the known universe – supports such affective states, but could a computer chip or dust cloud maintain the level of internal complexity needed for endless aeons of time under the extreme conditions of cold that Dyson envisions? One might easily imagine a 'man-in-the-street' reaction to this vision of a computer-chip existence in the outer darkness of a world forever approaching the coldness of absolute zero: 'If that's the best that Dyson has to offer, then I don't want it. I would prefer a normal human life – and death – to the "life everlasting" of the physicists.' Indeed, Dyson's vision of the remote future seems to bear more resemblance to the endless cryo-preservation of a human body in a persistent vegetative state or to the 'outer darkness' of the gospel tradition than to the 'abundant life' and 'life everlasting' of the Christian eschatological hope.

Such qualitative issues aside, however, Dyson's intellectually daring analysis

15 (Contd) processes that biologists would consider essential to the definition of life – *metabolism and replication* – Dyson focuses only on the former and essentially ignores the latter. His calculations are concerned to show that some future life-form might be able to store and metabolise energy indefinitely, without the necessity of reproducing itself.

16 Dyson deals only with the amount of energy presumably needed to support the life-form, and does not deal with the 'detailed architectural problems' of what physical structures and mechanisms might be able to actually capture this energy from the environment, store it, and then use it metabolically.

17 *Ibid.*, p. 459. Dyson also offers calculations [pp. 457–459] that presumably show that such life-forms could continue to communicate with each other across the vast reaches of space in an ever-expanding universe, but these calculations will not be considered in the present discussion.

is worthy of the most serious consideration on its own quantitative terms. Even at this level the proposal appears to be seriously if not fatally flawed. Dyson had admitted that his analysis proceeded with the assumptions that (1) the proton does not decay, and (2) black holes of arbitrarily small mass can not exist.¹⁸ If either of these assumptions turns out to be untrue, then matter is unstable, all material objects would disappear leaving only radiation, and the stable structures necessary for life would be impossible.¹⁹

Furthermore – and this appears to be a fatal flaw in the Dyson proposal – it seems that the Princeton physicist has failed to adequately take into account in his vision of the remotest future a degenerative process which he himself has recognised. As previously noted, on the time scale of $T = 10^{65}$ years, because of the quantum-mechanical effect of barrier penetration, every solid object behaves like a liquid, flowing into a spherical shape like a liquid, its molecules diffusing about like the molecules in a water droplet.²⁰ This means that any physical object – including Dyson's computer-like 'life-form' – will have its internal structure disorganised, given enough time. To restore the internal order and structure necessary for sentient life would require the expenditure of additional amounts of energy that have not been factored into Dyson's calculations.²¹ How could this additional energy be captured, stored, and processed in an environment that is approaching absolute zero in temperature?

Furthermore, the life-form continues to dissipate waste heat into space even when it 'hibernates' in its 'sleeping' state. The energy stored by the life-form is finite. Even though Dyson's model is based on a 'subjective time' as experienced by the life-form that *seems*, due to a slowed metabolism, to go on forever, in *real time* the physical processes of the Second Law of thermodynamics and the degenerative effects of quantum-mechanical barrier penetration continue to operate. A finite store of internal energy that continues to be dissipated into space can not forever support metabolism in real time; nor can an increasingly dilute store of energy in an ever-expanding space be effectively captured to repair the degenerative forces that inevitably destroy the life-form's internal structure. The consequence of this analysis is that Dyson's proposal ultimately fails: the 'hibernation' strategy is finally defeated by the inexorable, degenerative effects of the laws of thermodynamics and quantum mechanics. There is no longer sufficient energy available to support even the most minimal level of metabolic activity. Dyson's

18 *Ibid.*, pp. 450, 453.

19 At the time of this writing (1996), the empirical evidence concerning the stability or decay of the proton is inconclusive. Strictly speaking, if the proton does decay with an expected lifetime on the order of 10^{31} years, *all* matter would not cease to exist: there would still be a plasma-like cosmos consisting of electrons, positrons, neutrinos, and photons. Nevertheless, it is difficult to imagine a world in which the stable structures necessary for sentient life could be maintained with such components. In such a case there is the additional difficulty of preventing the electrons and positrons from annihilating one another in bursts of radiation.

20 Dyson, *op.cit.*, p. 452.

21 This criticism is also raised in the important article by Steven Frautschi, 'Entropy in an Expanding Universe,' *Science* 217: 4560 (13 August 1982): 593–599 at 599. At the time of writing Frautschi was a professor of physics at Cal Tech in Pasadena.

life-form, after the longest aeons of a 'virtual-reality' existence, finally expires in the heat-death and outer darkness of an ever-expanding universe.

The other scientific 'eschatology' to be discussed in this paper is that presented in John D. Barrow's and Frank J. Tipler's *The Anthropic Cosmological Principle* (1986),²² a major contribution to recent discussions of the issues of design in the universe and extraterrestrial life. In chapter ten of their book these authors address the question of 'The Future of the Universe.' They recognise that the generally prevailing understanding of the implications of the modern scientific worldview is that mankind is an 'insignificant accident lost in the immensity of the Cosmos', that the human species was an 'extremely fortuitous accident' unlikely to have occurred elsewhere in the visible universe, and that over the very longest reaches of time, '*Homo sapiens* must eventually become extinct.'²³

Barrow and Tipler develop a scenario concerning the ultimate fate of life in a closed universe, one that will finally collapse in upon itself in a 'Big Crunch.'²⁴ *Homo sapiens* may be inevitably doomed, but these authors believe that from a behavioural point of view, intelligent *machines* can be regarded as persons, and that under certain conditions they might be able to survive 'forever' under the extreme conditions near the 'Final State.' These intelligent machines [plasma-like computers?] would be our descendants, transmitting the values of the human race into an arbitrarily distant future.²⁵

In a scenario where the boundary between science fact and science fiction becomes very blurred, Barrow and Tipler tell us that life, beginning its expansion from earth, then proceeds to colonise outer space, and ultimately encompasses the entire Universe, even affecting the dynamical evolution of the cosmos itself. More and more information is processed at ever faster rates as the universe begins to collapse and to approach the final 'Big Crunch' singularity. In terms of the *subjective* time experienced by the intelligent machines, it seems that time lasts forever. Before the final Gotterdammerung-like collapse is reached, these machines attain what Barrow and Tipler call the 'Omega Point,' where life has gained control of all matter, has expanded into all universes that are logically possible, and will have stored an infinite amount of information – including every bit of information that it is logically possible to know. Life having achieved these God-like attributes, Barrow and Tipler modestly conclude that 'this is the end.'²⁶

22 See note 8 above. This same general point of view regarding the ultimate fate of the universe is presented in a somewhat more popular form in Tipler's highly speculative book, *The Physics of Immortality: Modern Cosmology, God and the Resurrection of the Dead* (New York: Doubleday, 1994).

23 Barrow and Tipler, *op.cit.*, pp. 613, 615.

24 At the present time astronomers generally believe that the available evidence is insufficient to decide the question of whether the universe is closed or open. In one recent discussion of this issue, on the basis of their reading of evidence from the Hubble space telescope, Petersen and Brandt conclude that it is somewhat more likely that 'we are constrained to live in [an open] universe that is expanding forever': Carolyn Collins Petersen and John C. Brandt, *Hubble Vision: Astronomy with the Hubble Space Telescope* (Cambridge: Cambridge University Press, 1995), p. 229.

25 Barrow and Tipler, *op.cit.*, p. 615.

26 *Ibid.*, pp. 675–677: the end of their book, and the end [final state] of life in the universe.

This emphatically 'Promethean' vision of an aggressively expanding life contrasts starkly with Dyson's 'minimalist' vision of hibernating life hanging on by the slenderest of threads in an ever-expanding, cold, dark universe. How much scientific plausibility does the Barrow-Tipler scenario in fact have?

One reviewer of Barrow and Tipler's work, the astronomer and physicist William Press of Harvard's Center for Astrophysics, acknowledges the considerable amount of valuable scientific and historical exposition in the book, but also points to its serious weaknesses. There is a distressing amount of 'mathematical flim-flam,' according to Press, that is, 'quotation of precise results in a manner designed to mislead less-mathematical readers,' leading them to jump to the authors' non-mathematical conclusions.²⁷ Like an inverted pyramid, the conclusions of Barrow and Tipler all too often represent very broad and sweeping generalisations supported by a rather narrow base of empirical data.

Another reviewer, Fred W. Hallberg, has pointed out that the Barrow-Tipler scenario is based on a chain of *nine* assumptions, each of which is quite debatable on empirical grounds. Some of these assumptions are that life and consciousness are inherently expansive, and would want to colonise the universe; that computers that could be preprogrammed to replicate themselves could actually be built; that digital computers could actually be conscious beings; that there would be a continuous upward trend in the amount of disposable income for future intelligent beings to afford the project of intergalactic colonisation; that future life could actually be embodied in the form of plasmas or energy fields rather than the molecular structures of the present; that these beings could actually maintain their metabolisms by using exotic sources of gravitational energy as the universe approached its final fiery collapse.²⁸ Not one of these assumptions is known to be true, and if even *one* of the assumptions were false, then the entire Barrow-Tipler scenario of life in the remotest future would collapse.

One of the critical assumptions made by Barrow and Tipler is that life could in fact maintain itself under the conditions of extreme heat that would characterise the universe as it approached the final state. One is led to agree with the simple conclusion of Jamal Islam, that there '... is very little hope for life of any kind surviving the big crunch in a closed universe.'²⁹ This critical assumption has

27 William H. Press, 'A Place for Teleology?' *Nature* 320 (27 March 1986): 315-316 at 315.

28 Fred W. Hallberg, 'Barrow and Tipler's Anthropic Cosmological Principle,' *Zygon* 23:2 (June 1988): 139-157 at 147-151. Hallberg points out that Barrow and Tipler seem to be inspired by the evolutionary speculations of the French Jesuit Teilhard de Chardin, *The Phenomenon of Man* (1959), in which de Chardin envisions life moving toward an 'Omega Point' of higher cosmic consciousness. The Barrow-Tipler thesis is also severely criticised by W.R. Stoeger and G.F.R. Ellis, 'A Response to Tipler's Omega-Point Theory' [Tipler, *The Physics of Immortality* (1994), a further extension of the Barrow-Tipler position of 1986], *Science and Christian Belief* 7:2 (1995): 163-172: in terms of its major elements, the theory '... is not testable even in principle, either scientifically or theologically - certainly not relative to its key conclusions,' p. 167.

29 Islam, *op.cit.* [n. 11 above], p. 114. Islam also raises (p. 134) the perceptive question, 'Can intelligent beings survive indefinitely the social conflicts ... that beset [modern] society?' The Barrow-Tipler thesis seems to naively expect that beings in the far distant future will not be afflicted with the wars, violence, crime and other socially destructive behaviours that have plagued all known societies from the dawn of history.

been subjected to a devastating critique by Ellis and Coule. There is simply no known physical theory that could support the idea that the complex, hierarchical structures necessary for life [or a computer] could be maintained under the intense conditions prevailing near the final state. Any such structures would be torn apart by the intense background radiation in a fraction of a second; any computer-like structure would be burned up, torn apart, and melted down into its component parts. The complex structures needed for life could not avoid being buffeted ' . . . by photons, electrons, positrons, quarks, and heavier particles at MeV [millions of electron volts] energies and beyond.'³⁰ The Barrow-Tipler scenario inevitably fails as 'life' is vaporised in the unspeakable heat of a universe in its final collapse.

Some Concluding Theological Reflections:

This analysis has shown, then, that at the end of the day, the attempts by Dyson, Barrow, and Tipler to overcome the 'thermodynamic pessimism' of the nineteenth century do not succeed. The inexorable working of the laws of physics, when extrapolated into the most remote reaches of time, provide no reasonable hope that sentient life can exist forever. Steven Weinberg's 1977 conclusion seems substantially correct: the final destiny of intelligent life³¹ is to be 'fried' in a closed universe or frozen in an open one. Despite the revolutionary new scientific discoveries that have occurred since the nineteenth century – special and general relativity, quantum mechanics, the expanding universe of 'Big Bang' cosmology – the fundamental scientific outlook is still the same; thermodynamic pessimism finally prevails.³²

From a theological perspective the new scientific eschatologies are significant even though they are not convincing on purely scientific grounds. The work of Dyson, Barrow, and Tipler could be seen as expressions at a particular historical period dominated by the scientific imagination of the perennial human search for *transcendence*. From the perspective of Christian theology, it is to be expected that human beings made in the image of God will seek in any culture and historical epoch to transcend the determinisms of circumstance and the iron necessities of physical law. Centuries ago St. Augustine expressed this irrepressible desire for transcendence, an implication of man's creation as *imago Dei*, in the well-known words of his *Confessions*: 'Thou hast made us for Thyself, and our heart is restless until it rests in Thee.'³³ The search for a scientifically-based

30 G.F.R. Ellis and D.H. Coule, 'Life at the End of the Universe?' *General Relativity and Gravitation* 26:7 (1994): 731–739 at 738.

31 Apart, of course, from the possibility of divine intervention – a possibility not entertained from Weinberg's naturalistic standpoint.

32 This is also the conclusion of Martin and Inge Goldstein, *op.cit.* [n. 3 above], p. 388: 'So it appears that in spite of the new insights of quantum mechanics and relativity, the grim inference for the future drawn from the second law in the nineteenth century is not far wrong.'

33 Saint Augustine, *Confessions*, tr. Vernon J. Bourke (Washington, D.C.: Catholic University of America Press, 1953), Bk.I, ch..1.

immortality is one form that the human quest for transcendence can take at the present stage of history.

Another observation that could be drawn from this analysis is that the unsuccessful attempts by Dyson, Tipler, and Barrow to establish secular versions of 'eternal life' provide yet another illustration of the wisdom of seeing the relationship of science and Christian faith as being one of *complementarity* rather than one of competition or dominance. That is to say, science and Christian faith inhabit a common universe and claim to know realities beyond the self, but know their respective realities through different methods, languages, and for quite different purposes.³⁴ Notable examples from the history of science, such as the Galileo affair in the seventeenth century,³⁵ and the development of modern geology in the late eighteenth and early nineteenth centuries,³⁶ show that Christian theologians went beyond the bounds of their proper competence when they attempted to substitute biblical exegesis for empirical research or to impose traditional interpretations of biblical texts regarding natural matters on the natural scientists. If churchmen have been tempted to engage in 'cognitive imperialism' in the centuries when the Christian faith has been more socially dominant, then perhaps the opposite danger is more real today. The natural sciences are now cognitively dominant in most areas of modern industrialised societies, and religion plays a more marginal role in shaping public life than in previous centuries.³⁷ Dyson, Barrow, and Tipler appear to be overstepping proper boundaries from the opposite direction when they attempt to use the methods of physics to argue for conclusions that are metaphysical and religious in nature. The history of the science-religion relationship indicates that both disciplines are best served when theologians do not attempt to derive empirical results from their religious texts, and when physicists do not presume to settle issues of value, meaning, and purpose by the scientific method.

Finally, it might be suggested that these secular eschatologies provide the

34 For a helpful discussion of various ways of understanding the relationship between religion and the natural sciences, see Ian G. Barbour, *Religion in An Age of Science* (London: SCM Press, 1990), esp. pp. 3–92. 'Ways of Relating Science and Religion.'

35 Jerome J. Langford, *Galileo, Science and the Church*, 3rd ed. (Ann Arbor: University of Michigan Press, 1966; 1992) provides a cogent analysis of the historical, scientific, and political dimensions of this pivotal controversy. The best analysis of the important role of presuppositions concerning biblical interpretation and theology is found in Richard J. Blackwell, *Galileo, Bellarmine, and the Bible* (Notre Dame, in: University of Notre Dame Press, 1991).

36 The valuable articles by Davis A. Young, 'Scripture in the Hands of the Geologists,' *Westminster Theological Journal* 49 (1987): 1–34 and 257–304, document the misguided attempts by some Christian workers during the early years of geology to derive geological data directly from the texts of scripture. It would seem that the 'Creation Science' movement today is repeating the errors of the past by continuing to treat biblical texts as (potentially) primary sources for strictly scientific conclusions. The most comprehensive scholarly account of the history and development of the modern 'Creation Science' movement is provided by Ronald L. Numbers, *The Creationists: The Evolution of Scientific Creationism* (Berkeley, CA: University of California Press, 1992).

37 The thesis of the 'privatisation' of religion in modern industrial societies has been developed in various ways by Peter Berger, *The Sacred Canopy: A Sociological Theory of Religion* (Garden City, NY: Doubleday, 1969), and David F. Wells, *God in the Wasteland: The Reality of Truth in a World of Fading Dreams* (Grand Rapids: Eerdmans, 1994).

church with a useful 'point of contact' for the communication of the Christian message in a scientific age.³⁸ The grim conclusions of physics are complemented by the biblical witness that attests that 'God *alone* has immortality'³⁹ – all created beings and all forms of life are perishable and doomed to extinction unless God freely wills, through grace, to bestow upon these creatures everlasting life. If, however, the human species is to find ultimate *hope*⁴⁰ of unending life in the face of the history of species extinction on planet Earth, that hope cannot be realistically supplied by the laws of physics. In the face of the pessimism and ultimate hopelessness implied by the inexorable laws of thermodynamics, Christian faith would point modern man to the reality of the resurrection of Jesus Christ, in which God has redemptively transcended the forces of disintegration and death, and 'brought life and immortality to light *through the gospel*.'⁴¹ For Christian faith, the grim prospects of a 'heat death' of the universe are transcended by the omnipotent power of God attested in the resurrection and by the hope of a transformed cosmos⁴² which will finally be transformed and liberated from its bondage to decay.

38 The concept of a 'point of contact' in the culture for the Christian message has been discussed, for example, by Helmut Thielicke, *The Evangelical Faith: v. I: Prolegomena: The Relation of Theology to Modern Thought Forms*, tr. Geoffrey W. Bromiley (Grand Rapids: Eerdmans, 1974), pp. 39, 139, 144ff. See also the discussion in a previous theological era by Paul Tillich of his 'method of correlation' ['The method of correlation explains the contents of the Christian faith through existential questions and theological answers in mutual interdependence'] and 'apologetic theology' ['Apologetic theology . . . answers the question implied in the "situation" in the power of the eternal message, and with the means provided by the situation whose questions it answers'] in Paul Tillich, *Systematic Theology: Three Volumes in One* (Chicago: University of Chicago Press, 1967), v. 1, pp. 6, 60.

39 I Timothy 6:16, emphasis added.

40 In recent Protestant theology the theme of hope has been most systematically developed by Jurgen Moltmann, *Theology of Hope: On the Ground and the Implications of a Christian Eschatology*, tr. James W. Leitch (London: SCM Press, 1967). For Moltmann, hope is ' . . . the foundation and the mainspring of theological thinking as such,' and the resurrection of Christ is not only a ' . . . consolation in a life . . . doomed to die, but it is God's contradiction of suffering and death,' pp. 19, 21. In a secular context, the importance of a future hope as a critical factor in the experience of many who survived the Nazi death camps is documented in the fascinating work of the Viennese psychiatrist Viktor E. Frankl, *Man's Search for Meaning: An Introduction to Logotherapy* (Boston: Beacon Press, 1962). The story of how the Christian church and its message provided a sense of hope to many pagans amidst the growing pessimism of late antiquity is documented in E.R. Dodds, *Pagan and Christian in an Age of Anxiety* (Cambridge: Cambridge University Press, 1965), focusing on the period from Marcus Aurelius to Constantine.

41 II Timothy 1:10, emphasis added.

42 Romans 8:21, 22; Rev. 21:1.

BIOETHICS AND THE NEW BIOLOGY

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