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## Science and Eschatology in the Open Universe

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*This article explores possibilities of a rapprochement between Christian eschatology and the scientific enquiry into the future of the universe through a discussion of contemporary literature from three fields: a. data from the natural sciences about the universe, its development and future, b. research on the relationship between mind and body, and c. theology and the study of divine action. The article argues for an interdisciplinary approach to eschatology in which the overall perspective of an open (that is, not completely deterministic) universe is taken into account. The second part of the article consists of a set of 'eschatological options', that is, possible relationships among these three sets of data as found in the still quite scarce literature on eschatology and science, what they might imply for the future of humanity and the universe, and what ethical and eschatopractical consequences they entail.*

**Key words:** eschatology, future of the universe, mind-body relationship, miracle, indeterminism, thermodynamics, emergence, fine-tuning, incompleteness, open universe.

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The gradual discovery in recent centuries of the enormous dimensions of the universe has increasingly presented humanity with a cosmos that dwarfs it in terms of space and time. The universe's sheer vastness on its own suggests an enormous future, which automatically raises the question of what this holds in store for humanity. For Christian theology this implies the need to articulate the doctrines of the Second Coming, the end of the world, the fulfilment of history and the renewal of creation in the context of contemporary cosmology. The subject of the future of the universe has in all fields of research been approached with some reserve in the last few decades. Physical eschatology, after its hesitant emergence as a branch of cosmology in its own right,<sup>1</sup> has changed considerably recently, while interdisciplinary thought about eschatology is still in its infancy. The dialogue between science and Christian eschatology is marked by a 'surprising lack of engagement',<sup>2</sup> although the last few years have seen some significant contributions to the still scarce literature thereon. The humanities in turn have hardly begun to become involved, the work of the philosopher J. Leslie being a noteworthy exception.<sup>3</sup>

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1 See Cirkovic, M. 'A Resource Letter on Physical Eschatology' (2002), online at <http://arxiv.org/ftp/astro-ph/papers/0211/0211413.pdf>. The retrieval date of all internet sources in this paper is 31 Dec. 2010.

2 Russell, R. J. *Cosmology from Alpha to Omega*, Minneapolis: Fortress Press (2008), p. 302.

3 Leslie, J. *The End of the World*, London: Routledge (1998).

This lack of engagement may of course simply be due to formidable epistemic barriers: the future simply does not lend itself to scientific enquiry in the way that the study of the past development of the cosmos and of human history does. This point is reinforced by the natural sciences' – including logic's and mathematics' – development away from both the Laplacian view of the cosmos as completely predictable, and from steady-state cosmologies that conceive of it as essentially unchanging, in favour of an 'open universe'<sup>4</sup> which evolves in time, coming up with novelties and surprises and, while being lawlike and intelligible, is not completely deterministic.

The challenge for such a dialogue between physical and theological eschatology is a double one: on the one hand, the sheer vastness of space-time does not at first sight suggest that the end of humanity will coincide with the end of the universe as traditional eschatology has generally held, while on the other, thermodynamics predicts that *any* conscious living organisms will ultimately fall victim to decay. P. C. W. Davies' words adequately put what classical Christian eschatology would expect: 'if there is a purpose to the universe, and it achieves that purpose, then the universe must end, for its continued existence would be gratuitous and pointless.'<sup>5</sup>

While the 'open universe' perspective – if it is correct, as I shall attempt to argue below – should make us wary of overconfident predictions of the future, from whatever sources these may come, my claim is that a rational discourse about the future of the universe is both possible and necessary and, furthermore, that such an endeavour is necessarily an interdisciplinary one. This holds true if the different types of reductionist philosophies are inadequate approaches to reality.<sup>6</sup> For if materialistic reductionism applies, then eschatology should be left to the natural sciences alone. As for life, the future of the universe would then hold no promise for it, because thermodynamics predicts with certainty the decay of the material substrate on which life and consciousness are based. If, on the other hand, idealist and constructivist reductionism is correct – and even some physicists seem to flirt with this philosophy<sup>7</sup> – then the world will by definition end with its last observer, and there would be no sense in discussing the future of the physical universe independently of conscious observers. A Christian approach to the future of the universe, adhering to the general perspective that the material world is real, good, and unfolds autonomously according to its own laws given to it by God, but also that the human soul is irreducible to a material substrate and that the cosmos is intimately connected with man, will steer clear of both materialistic and idealistic reductionisms.

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4 See esp. Popper, K. *The Open Universe: An Argument for Indeterminism*, Totowa: Rowman and Littlefield (1982).

5 Davies, P.C.W. *The Last Three Minutes*, London: Weidenfeld & Nicolson (1994), p. 155.

6 On eschatological implications of a non-reductionist approach, see also Ellis, G.F.R. 'Natures of existence (Temporal and Eternal)', in Ellis, G. F. R. (ed.) *The Far-Future Universe: Eschatology from a Cosmic Perspective*, London: Templeton (2002), pp. 316-354.

In the first part of this article, I will lay out how the following three fields of research contribute to the interdisciplinary eschatological discourse, arguing that each one of them needs to be taken into account in order for such a discourse to be complete:

- A. the data science has furnished us about the characteristics of the universe, its age, size and development, as well as science's predictions for the future of the universe;
- B. the ontology of conscious beings living within the universe, the mind-body problem, and the question as to what the role of these beings is within the universe;
- C. theology – focusing especially on divine action.

### **A. The contribution from the natural sciences**

Many insights furnished to us by science can inform the dialogue between science and eschatology, of which the following seem especially noteworthy.

First is the enormous spatio-temporal dimensions of the observable universe alone, as already pointed out. The fact that we are living in an approximately fourteen billion year-old universe comprising something of the order of a hundred billion galaxies, with a hundred billion stars each, in our light-cone alone, has conveyed to countless thinkers the impression that human beings are of little or no significance for the cosmos,<sup>8</sup> while the sheer time-scales we now know nature to operate in suggest a future several orders of magnitude longer than that of human history, quite independently of the findings of physical eschatology.

This impression of the insignificance of life and consciousness for the universe has of course been importantly challenged through the discovery of the now famous fine-tuning of the numerical values of the four fundamental forces of nature and of the masses of elementary particles that allow life to evolve in the universe. While there is a wide array of possible interpretations thereof,<sup>9</sup> the fine-tuning permits us with relative ease to infer that we are the end – in

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7 I am thinking of what might be called 'quantum idealism', as put forward e.g. in Zeilinger, A. 'Three challenges from John Archibald Wheeler', in Barrow, J.D., Davies, P.C.W., Harper, C.L. (eds.) *Science and Ultimate Reality*, Cambridge: Cambridge University Press (2004), pp. 201-220; and A. Linde: 'the moment you say the universe exists without conscious observers, I cannot make sense out of that. I cannot imagine a consistent theory of everything that ignores consciousness', in Folger, T. 'Does the universe exist if we're not looking?', *Discover* (2002) 6, online at <http://discover-magazine.com/2002/jun/featuniverse>

8 Perhaps most famously expressed in Monod's image of the 'gypsy on the boundary of an alien world', Monod, J. *Chance and Necessity*, New York: Random House (1971), pp. 172-173.

9 For a systematic discussion, see e.g. Barrow, J. D., Tipler, F. J. *The Anthropic Cosmological Principle*, Oxford: Oxford University Press (1986); and Davies, P. C. W. *The Goldilocks Enigma*, London: Penguin Books (2006).

the sense of *moral* end or purpose – of the universe, or at least a part of this end. Indeed, many contemporary authors have again turned to a teleological interpretation of the universe, making the point that the universe has attained self-awareness through the emergence of the human species, that ‘the universe in some sense must have known we were coming’,<sup>10</sup> that ‘we were meant to be here’,<sup>11</sup> and so forth. For the philosopher and physicist Dominique Lambert, human beings have eschatological significance because they in a sense sum up the previous history of the universe, every human body being ‘a kind of recapitulation of cosmic history’.<sup>12</sup> These insights, underlining the intimate relationship between man and the cosmos, do indeed seem of crucial importance for an interdisciplinary eschatological discourse, but on their own they do not suffice to address the challenges mentioned above, since the prospect of life’s eventual and inevitable demise can with equal right be interpreted as dysteleological.

### **The open universe**

As stated in the introduction, the general perspective of an open universe<sup>13</sup> is of decisive importance for the dialogue between science and Christian eschatology. By ‘open universe’, following K. Popper, I mean one where Laplace’s assertion that a hypothetical intelligence possessing complete knowledge of the present state of the universe, together with all the laws of nature, could thereby predict the future in such a way that ‘nothing would be uncertain’,<sup>14</sup> does not hold true; equivalently, the universe features novelties that cannot be predicted in principle from antecedent states. The following developments in science that have contributed to the open universe perspective also inform eschatological thought in important ways:

- Research in the foundations of mathematics, especially the family of incompleteness theorems of K. Gödel for systems containing arithmetic, and of A. Turing and A. Church for computer programmes, and their bearing on the philosophy of science as a whole. Gödel’s incompleteness theorems in essence state that any consistent logical system containing arithmetic must be incomplete, that is, contain statements that are true but not provable within the system.<sup>15</sup> Since mathematics underlies natural science, as experience has hitherto confirmed, the upshot is that there are

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10 Dyson, F. *Disturbing the Universe*, New York: Harper & Row (1979), p. 250.

11 Davies, P.C.W. *The Mind of God*, London: Penguin Books (1992), p. 234.

12 Lambert, D. *Sciences et théologie: Les figures d'un dialogue*, Namur: Lessius (1999), p. 158. Translations from foreign language sources in this paper are by the author.

13 See Popper, K. *op. cit.*, (4), and Weyl, H. *The Open World*, New Haven: Yale University Press (1932).

14 Laplace, P. *Essai Philosophique sur les probabilités*, Bruxelles (1829), p. 3.

15 See e.g. Nagel, E., Newman, J. R. *Gödel's Proof*, London: Routledge and K. Paul (1976).

things that science cannot predict, if it is to be consistent.<sup>16</sup>

- The discovery that we are living in an evolving cosmos, whose story we have been able to unravel remarkably well, a cosmos with an arrow of time, the direction of which is imparted to it by the time-asymmetry that follows from the second law of thermodynamics.<sup>17</sup> Especially striking is the contrast between the two great trends observable in the universe of the inexorable march of ever-increasing entropy on the one hand, and the continuous emergence of structures of sometimes staggering complexity on the other. The latter does not happen *in spite of* the second law of thermodynamics and, as I. Stewart and P. Davies suggest, the complexification of matter may have a lot to do with gravitational clumping, the aggregation of matter (especially gas) through the effect of gravity to form structures such as galaxies.<sup>18</sup> On the other hand, there seems to be no way whereby these emergent novelties, and especially the appearance of life and conscious beings on the cosmic scene, could be predicted from antecedent states.<sup>19</sup>
- Popper argues<sup>20</sup> that a Laplacian demon is impossible in principle because of the restrictions imposed by the finite speed of light, along the following lines. Supposing an observer is situated at point A in the graph<sup>21</sup> below. Her present state is then determined by those regions of space-time from which light has had time to reach her – those within the branch of the light cone to the left of point A, constituting the past from her perspective. In the same way, she can only exert any causal influence in the regions which can be reached by light from point A – the branch of the light cone to the right of A. Supposing further that the person wished to predict the state of affairs at a future point B. She only has access to a part of the necessary information, since there are points in B's past light cone which are not in A's. While this shows that our observer cannot predict her future with certainty, this restriction should not apply to a being

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16 Thus S. Hawking: 'So if there are mathematical results that cannot be proved, there are physical problems that cannot be predicted.', in Hawking, S. 'Gödel and the End of Physics'(2003), online at <http://www.hawking.org.uk/index.php/lectures/91godelendofphysics?format=pdf>, p. 5. This does not mean that the universe cannot thereby in principle be described by a Grand Unified Theory capable of unifying all the laws of physics, or that the search for such a theory is in vain. Gödel's theorem of course does not show that such a theory is impossible, only that it could not predict every event, and would also be in need of an explanation beyond itself. On this point see Weizsäcker C. F. *Große Physiker*, Munich: Carl Hanser (1999), pp. 7-22.

17 See Stewart, I. 'The Second Law of Gravitics and the Fourth Law of Thermodynamics', in Gregersen, N. H. *From Complexity to Life: On the Emergence of Life and Meaning*, Oxford: Oxford University Press (2003), pp. 114-150. Stewart emphasises that thermodynamics does not explain why time exists, but gives it a direction (p. 121-123).

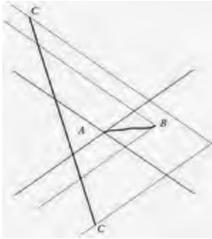
18 Stewart *op. cit.*, (17), pp. 129-131; and Davies, P. C. W. 'Complexity and the arrow of time', in Gregersen, N. H. *op. cit.*, (17), pp. 72-92.

19 Davies, P. C. W. *Cosmic Blueprint*, London: Penguin Books (1987), pp. 112-113.

20 In Popper K. *op. cit.*, (4), pp. 57-62.

21 Taken from *ibid.*, p. 61.

– a Laplacian demon – in possession of a complete description of a finite region greater than or equal to that of B's past light cone at a given moment, indicated by the line C. With this information, the demon can



calculate the future at point B. However, because of the limited speed of light, the demon would need to be located at least at point B in order to obtain the necessary information, or further in the future. Thus, the demon's prediction is not a prediction at all, but a retro-diction from the future to the past, rather than the other way round. Hence, a Laplacian demon cannot exist in a universe where the speed of light is finite.

- Quantum theory and, in a different way, chaos theory, have loosened the rigid determinism of classical physics, and together reinforce the picture of an open future of the universe. The former is, according to current understanding, *ontologically* indeterministic. The latter is deterministic, but introduces an ineliminable uncertainty *epistemically* (simply because one can only calculate with a finite number of digits, so that rounding errors inevitably arise).<sup>22</sup> Thus, tiny, unpredictable quantum fluctuations can be amplified in such a way as to affect space-time on a large scale, as for example in the small perturbations in the early universe that would become today's galaxies.<sup>23</sup> Quantum indeterminacy is also sometimes invoked for providing the necessary openness of the physical world to both mind-body interaction and divine action, as will be discussed below.

If then the universe is described by mathematics, and consistent mathematics is necessarily incomplete, and if, moreover, this universe is also marked by a timeline, an evolutionary character and an intrinsically open future, might this point towards an eschatological character of the universe, such that it 'awaits' a completion that cannot be a result merely of its inherent potential, but needs to come from without?<sup>24</sup> This, of course, is speculative, but it seems clear that interdisciplinary thought on eschatology needs to reflect on the philosophical implications of the above areas of research.

### **Physical eschatology**

Though the open character of the universe needs to be born in mind in this discussion, it does not follow that there is no sense at all in making predictions. The upshot of the above considerations about the open universe perspective

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<sup>22</sup> Russell, R. J. *op. cit.*, (2), p. 130.

<sup>23</sup> Ellis, G. F. R. 'Physics in the real universe: time and spacetime' (2006), online at: <http://www.mth.uct.ac.za/~ellis/SpaceTime.pdf>, p. 13.

<sup>24</sup> cf. J. Haught's view that God continuously comes from the future to an unfinished universe; Haught, J. F. *Christianity and Science: Toward a Theology of Nature*, New York: Orbis Books (2007), pp. 161-162.

seems rather to be that predictions are partial and incomplete, but not altogether futile, and that the story of the universe is one of both continuity and surprise. Indeed, the discipline of physical eschatology has seen important changes in the last two decades. Until recently, the discussion on physical eschatology centred principally on three scenarios:<sup>25</sup>

1. the 'closed universe', whose density,  $\rho$ , exceeds a critical value  $\rho_{\text{crit}}$ , imparting a spherical geometry on it. Here, the effect of gravity will in the far future be such as to overpower the universe's expansion, thus leading it to recollapse in a 'Big Crunch';
2. the 'marginally bound' or 'flat universe', where  $\rho = \rho_{\text{crit}}$ , the universe's expansion will never come to a halt, but its expansion rate will asymptotically approach zero;
3. the 'open universe' (this has nothing to do with the use of this term we made earlier and as employed by Popper), which is marked by a hyperbolic geometry. Its expansion rate will reach a fixed value, at which it will continue to expand for ever.

In recent years, however, observations of type Ia supernovae by two independent research groups indicate that the expansion of the universe is accelerating, contrary to all three models. We have very little inkling at present of what is doing this, though many physicists think that the cosmological constant, a term in Einstein's field equations, may be responsible. As is well known, our ignorance of the physics behind the cosmological constant, and the fact that the nature of some 95% of the energy density of the universe is obscure, for the moment makes physical eschatology a very speculative business. In addition, the above trichotomy has seen a substantial enrichment in recent years as several researchers have come up with alternative scenarios:

- the Big Rip – the expansion force will rip everything apart, from galaxies right down to atoms, at a finite time in the future. The usual estimates for this to happen are given in tens of billions of years;<sup>26</sup>
- the Sudden Future Singularities – discovered by M. Dąbrowski and J. D. Barrow,<sup>27</sup> the universe will undergo infinite tidal forces at a finite time in the future, squashing everything. These 'weak' singularities, however, do not mark the end of the development of the universe, which would thereafter continue to expand before reaching another singularity, such as a Big Rip, at a later stage;

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25 See Turl, J. 'All Things New', *Science & Christian Belief* (2007), 19, 142; and Davies, P. *op. cit.*, (9), pp. 140-142.

26 Vaas, R. 'Phantom-Energie zerreißt das Weltall', *Bild der Wissenschaft* 8/2003, 52- 57.

27 See e.g. Dąbrowski, M. 'Future state of the universe' (2006), online at <http://arxiv.org/abs/astro-ph/0606574> ; Barrow, J. D. 'Sudden future singularities' (2008), online at <http://arxiv.org/abs/gr-qc/0403084>

- the new development of generalised Chaplygin gas cosmology<sup>28</sup> – the pressure of the universe is here governed by an exotic equation<sup>29</sup> that permits a unified description of dark matter and dark energy, despite their contrary effects of inward pull and outward push. If Chaplygin gas cosmology is correct, the entire universe could undergo a sudden deceleration ('Big Brake') leading to a singularity of pressure in the extraordinarily near future, even within the next ten million years. These would destroy everything in it, whereupon the universe would remain as a frozen mush of subatomic particles for ever;
- a 'Big Lurch', that is, a singularity of infinite pressure due to 'matter work[ing] itself up in a frenzy', possibly bringing about an end of time, is conceivable 'as soon as nine million years from now'.<sup>30</sup>

The list is not exhaustive, but these developments seem to indicate that physical eschatology has become more varied and has developed away from the idea that we can confidently predict the future of the universe by determining a few basic parameters. In the words of L. Krauss and M. Turner, 'We teach undergraduates that the Universe can exist in one of three different geometries, open, closed and flat, and that once we determine which describes our universe, this fixes its fate... [however] there is no set of cosmological observations we can perform that will unambiguously allow us to determine what the ultimate destiny of the universe will be.'<sup>31</sup>

## B. The contribution from research on mind-body relationship

The mind-body problem has been the subject of much debate in *Science and Christian Belief* in recent years. My intention here is not to propose any solution to this extremely difficult enquiry, but rather to relate recent developments in this field to eschatological thought. The mind-body problem can be summarised in the form of three statements that cannot all at once be true:<sup>32</sup>

1. mental events are not the same as physical events;
2. mental events have effects in the physical realm;
3. the physical realm is causally closed.

Materialistic eliminativism, which holds that mental phenomena are essen-

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28 See Bouhmadi-Lopez, M., Gonzalez-Diaz, P., Martin-Moruno, P. 'Worse than Big Rip', online at <http://arxiv.org/abs/gr-qc/0612135> ; Vaas, R. 'Weltall in der Schockstarre', *Bild der Wissenschaft* 4/2010, 42-49.

29  $p = -A/\rho^\alpha$ , where  $p$  is pressure,  $\rho$  is density,  $A$  is a positive constant, and  $0 \leq \alpha \leq 1$ . In other words, pressure is negative and inversely proportional to density to the power  $\alpha$  (i.e. generalised Chaplygin gas).

30 Musser, G. 'Could time end?' *Scientific American* (2010), 303(3), 68.

31 Krauss, L., Turner, M. 'Geometry and Destiny' (date unknown), online at: <http://cdsweb.cern.ch/record/383758/files/9904020.pdf>, pp. 1-2.

32 Goller, H. *Das Rätsel von Körper und Geist: Eine philosophische Deutung*, Darmstadt: Primus (2003), p. 87.

tially illusions, denies the first statement, but accepts the second and the third as true. Epiphenomenalism – where mental events are seen as real but devoid of causal power – and the Leibnizian idea of a pre-established harmony between mental and physical events reject the second statement but accept the first and the third. Dualistic interactionism holds that the third is false, but that the first and second are true. Clearly, which of these answers is correct has great bearing on interdisciplinary eschatology: if it is eliminativism, thermodynamic decay will eventually spell the end of mental phenomena, so that matter will outlive mind. In the case of interactionism, where both bottom-up and top-down causation are allowed for, conscious beings may be expected to play an active part in shaping the universe and influencing its future. If both the mental and the physical are equally real, but do not interact, one might, for example, imagine the long-term future of the universe as disembodied souls existing parallel to decaying matter.

But which of the three statements ought we to reject? The respective inputs from different fields give a quite varied picture. Many, perhaps even most, neuroscientists are convinced by evidence such as the psychological testing of patients with brain injury, as well as the possibility of eliciting emotions and experiences by electrical stimulation of the brain, that not only does every mental event have a physical correlate, but that immaterial causes interacting with the brain can be entirely dispensed with.<sup>33</sup>

Nevertheless, philosophical objections to a purely physicalist understanding of the human mind remain, such as the apparent insusceptibility of *qualia* to explanation in neurological terms,<sup>34</sup> or the existence of artefacts as manifestations of mental activity in the physical world, which would not seem possible if the human mind were not causally efficacious.<sup>35</sup> A relatively novel input to the discussion comes from J. Lucas<sup>36</sup> and R. Penrose's<sup>37</sup> arguments for the impossibility of conceiving human mathematical understanding as the activity of a Turing machine. Furthermore, it seems significant that the case for indeterminism laid out in the first part of this paper gives strong reasons to drop the assumption of the causal closure of the world, so that the universe could in principle be thought of as open to the influence of non-physical causes, if such exist.

It is of course beyond the scope of this paper to develop a position on the perennial conundrum of the mind-body problem. I suggest instead that the picture the interdisciplinary discourse on this problem conveys of human beings

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33 Clarke, P. G. H. 'Neuroscience and the soul – a response to Malcolm Jeeves', *Science & Christian Belief* (2009) 21, 61-64.

34 Chalmers, D. 'Facing up to the problem of consciousness', *Journal of Consciousness Studies* (1995) 2(3), 200-219. Examples of *qualia* are the taste of wine, the redness of the sunset, the feelings of joy or anger, etc.

35 Popper, *op. cit.*, (4), pp. 113-130.

36 Lucas, J. R. *The Freedom of the Will*, Oxford: Clarendon Press (1970).

37 Penrose, R. *Shadows of the Mind*, Oxford: Oxford University Press (1994).

as psychosomatic unities, rather than ghosts in machines, together with the huge, perhaps insurmountable obstacles to understanding them in terms of the physical alone, has something to offer for eschatological thought. Thomas Aquinas, for example, saw in similar considerations ‘an intimation of, but not an argument for, the resurrection of the body’.<sup>38</sup> More generally, if the universe features conscious physical beings, and a reductionist understanding of such beings is not viable, this cautions us against reductionist approaches to the universe and its development as a whole, suggesting that the same also applies to eschatology.

### C. The contribution from theology

The epistemic status of theology’s contribution to the interdisciplinary eschatological discourse is different from the contributions provided by the natural sciences, since, unlike physical eschatology, theology does not approach the topic of the future of the universe through extrapolations of the laws of nature, but rather on the basis of a divinely revealed promise for God’s salvific action in the future, by way of a *memoria futuri*: if God has acted salvifically in the past, we have reason to believe the promise that he will do so in the future.

But what are the reasons for believing in such a promise? I propose that the open universe perspective has something to offer here. First, it contributes to natural theology. Indeed, many of the developments in science mentioned so far, such as Gödelian incompleteness, the inadequacy of reductionist approaches in the debate about emergence, especially as regards the human mind, and also the discovery of fine-tuning, have led to some remarkable work in this area.<sup>39</sup> To lay out an argument here is however beyond the scope of this paper. Secondly, the open-universe perspective has great bearing on the question of the occurrence and nature of special divine action in nature and history. Readers will be aware that the issue of divine action in an indeterministic universe, and especially the hypothesis that God acts continuously at the quantum level, has been explored and debated extensively in science and theology literature, especially the publications of the series ‘Scientific Perspectives on Divine Action’ (SPDA).<sup>40</sup>

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38 McNerny, R. ‘Saint Thomas Aquinas’, in *Stanford Encyclopedia of Philosophy* (2009), online at: <http://plato.stanford.edu/entries/aquinas/>

39 An in my view impressive reflection on non-reductionism, emergence and metaphysics is provided in Ellis, G.F.R. *op. cit.*, (6), pp. 316-354. Concerning specifically the human mind and natural theology, see Eccles *Evolution of the Brain: Creation of the Self*, London: Routledge (1989), chap. 10.

40 The series has five volumes: Russell, R. J., Murphy, N., Isham, C. J. (eds.) *Quantum Cosmology and the Laws of Nature*, Vatican Observatory (1993); Russell, R. J., Murphy, N., Peacocke, A. R. (eds.) *Chaos and Complexity*, Notre Dame, IN: University of Notre Dame Press (1996); Russell, R. J., Stoeger, W. R., Ayala, F. J. (eds.) *Evolutionary and Molecular Biology*, Notre Dame, IN: University of Notre Dame Press (1999); Russell, R. J., Murphy, N., Meyering, T. C., Arbib, M. A. (eds.) *Neuroscience and the Person*, Notre Dame, IN: University of Notre Dame Press (2000); Russell, R. J., Clayton, P., McNelly, K. W., Polkinghorne, J. C. *Quantum Mechanics*, Vatican Observatory (2002).

How the open universe perspective here makes a difference to the Laplacian one can be illustrated using, as we did above for the mind-body problem, a scheme of three statements that cannot all at once be true:

1. an event brought about by special divine action – a miracle – is not the same as an event brought about by the causal power of nature;<sup>41</sup>
2. special divine action has effects in nature;
3. the natural realm is causally closed.

Those who assume the third will either need to reject the first, so that divine action is identical to purely natural events, leading either to pantheism or, if they admit one special divine act at the beginning of time, deism. Or, they may reject the second and hold that direct divine action happens in some totally isolated realm without physical effects, or in the mind of the believer alone (assuming that the mind too is isolated from the physical). The upshot in either case is that divine action makes no difference – it is either non-existent or undetectable, except perhaps through purely subjective experience.

Post-enlightenment thought on miracles has been dominated by philosophical views that assumed the causal closure of the physical, exemplified by the thought of Hume and Kant. Both held that it was necessary to assume a seamless chain of cause and effect in nature, lest rational thought and scientific enquiry themselves break down. Any happenstance that did not fit into this chain was taken to be both contrary to the laws of nature (rather than just exceeding it), and offensive to reason.<sup>42</sup> This idea of miracles as conflicting with the laws of nature and with science in its endeavour to explain the natural world has 'left an indelible impression on modern biblical scholarship'<sup>43</sup> through the influence of New Testament (NT) scholars such as D. F. Strauß and R. Bultmann. As A. O. Søvik has recently argued,<sup>44</sup> since a large part of the volume of the Gospels is made up of accounts of miracles, there would be little reason to trust them concerning much else if it is assumed that miracles do not happen in principle. The result is a strong separation between the Jesus of the Gospels and the Jesus of history. But even theologians who support the historicity of the Gospel miracle accounts often accept the Humean definition of a

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41 'Nature' is here understood in the broad sense, i.e. as distinct from the supernatural and including human history, not the realms of the physical, chemical and biological alone. Otherwise, a person throwing a rock upwards would perform a miracle, as Aquinas notes in the *Summa Theologiae* I, q. 110, a. 4.

42 Hume takes for granted a strict mechanism in the physical world and in human behaviour, (see e.g. *Enquiry Concerning Human Understanding*, section VIII, part I, 64 and 68). Presumably, it is this basic assumption that leads Hume to introduce the definition of miracles as 'violations of laws of nature' (sect. X, p. I, 90), and hence something that can be dismissed out of hand (sect. X, p. II, 99). Kant focuses more on the epistemic side: the occurrence of a miracle would shatter our confidence in the laws of nature (*Die Religion innerhalb der Grenzen der bloßen Vernunft*, B 120- 124).

43 McGrew, T. 'Miracles', in *Stanford Encyclopedia of Philosophy* (2010), 3.3.

44 Søvik, A. O. 'Why Christian theology should accept that miracles occur', *Science & Christian Belief* (2010) 22, 151-165.

miracle as a violation of a law of nature.<sup>45</sup>

It is hardly evident though that this is the traditional Christian understanding. Theologians such as Augustine and Thomas Aquinas were familiar with the idea that miracles happen ‘against nature’ but have refuted it. Instead, these thinkers maintain that miracles exceed, rather than contravene, the ordinary course of nature.<sup>46</sup> As argued above, such a conception of something beyond, but not against the laws of nature is unintelligible for the proponents of the third premise. There appear to be many reasons though to reject the assumption of a closed universe, as laid out in this article so far.

Moreover, as the *Stanford Encyclopaedia of Philosophy* points out, the Humean definition has several conceptual problems. What does it mean for a law of nature to be violated? Which law is being violated in a given case claimed to be of miraculous nature, for example the resurrection of Jesus? What is the ontological status of these laws in the first place? These considerations have led the philosopher J.L. Mackie to revise the Humean definition to one more in line with the understanding whereby miracles exceed, rather than violate, the ordinary course of nature.<sup>47</sup>

The Augustinian-Thomistic view needs to be distinguished from the one recently proposed by D. Edwards, who proposes that not only are there no violations of the laws of nature, but that God consistently acts through second causes alone.<sup>48</sup> Edwards’ intention is to preserve the integrity of nature, but to propose that there is no direct divine action in nature or history seems an unnecessary move in order to do this. Indeed, if every event is brought about by secondary causes, one wonders why we should distinguish between primary and secondary causality in the first place.

However, whether the concept of miracle is consistent is one issue, whether there actually are events which qualify as such quite another. There is consensus in the scarce literature on science and eschatology that the pivotal instance of divine action in history, the one which inaugurates the renewal of the physical universe, is the resurrection of Jesus.<sup>49</sup> Why ought we to believe that this event really took place? The force of the historical argument in its favour is certainly illustrated by the impression it has made on non-Christians who have studied it, such as the late A. Flew,<sup>50</sup> Jewish theologian P. Lapide,<sup>51</sup> and the

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45 e.g. R. Swinburne in his book *The Resurrection of God Incarnate*, Oxford: Oxford University Press (2003), p. 23.

46 Augustine, *Contra Faustum*, XXIX, 2; Thomas Aquinas, *Compendium theologiae*, 1,136.

47 McGrew, T. *op. cit.*, (43), 1.2.

48 Edwards, D. *How God Acts: Creation, Redemption, and Special Divine Action*, Minneapolis: Fortress Press (2010), pp. 77-84.

49 See on this point esp. Russell, R. J. *op. cit.*, (2), chaps. 9 & 10; Polkinghorne, J. *The God of Hope and the End of the World*, New Haven: Yale University Press (2002), p. 113.

50 Flew, A., Varghese, R. A. *There is a God: How the world’s most notorious atheist changed his mind*, New York: Harper Collins (2008), p. 213.

51 Lapide, P. *Auferstehung: ein jüdisches Glaubenserlebnis*, München: Kösel (1991).

journalist A. H. Ross.<sup>52</sup> Not being a historian, I cannot add anything to this.

But a sceptic could still counter that, despite all of the above, it is remarkable that miracle reports abound in the Bible and in the Christian Middle Ages, but have since ceased, showing that they melt away under the bright sunlight of the type of scientific scrutiny that was only applied in recent centuries, and thus undermining the credibility of biblical miracle reports.<sup>53</sup> This too appears not to be the case: physician and historian J. Duffin who set out as a 'sceptic, even atheist'<sup>54</sup> to explore records of miracles from the years 1588 – 1999 stored in the Vatican concludes her recent study *Medical Miracles* by expressing her satisfaction with the scientific standard exhibited in these records, and states that she believes the events in question are of miraculous nature.<sup>55</sup>

My suggestion, then, is that an interdisciplinary approach to divine action as sketched out above can dispel preconceived notions that run the risk of distorting historical enquiry into the New Testament, especially the notion of special divine action as violation of natural laws, and hence as something which is either undetectable or can be dismissed out of hand. I am not, however, suggesting that historians are wrong to submit the New Testament to historical scrutiny and ask tough questions about what really happened.

If, as I submit, we have reasons to believe in divine action in the world, then theology's approach of *memoria futuri* and the promise associated with it deserves to be taken seriously. Let us look at the data provided by Scripture and Christian theology throughout the ages about this promise, and how they might inform the dialogue with scientific eschatology. Especially relevant for the relationship between science and eschatology are the passages that indicate matter's tendency towards decay (e.g. Rom. 8:19-23; 2 Pet. 3:10-12; Is. 34:4) – what we today might call increasing entropy – as well as the transitory nature of the physical universe (Mk 13:31; Heb. 12:26-27). Then also those that underline our ignorance as to the when and where of the end of the universe (Mk 13:32-37; Acts 1:7), and that we ought to reckon with different orders of magnitude of time than we are wont to think in (2 Pet. 3:8), together with the numerous passages according to which we are already in the final age and Christ's return can be expected very soon (e.g. 1 Cor. 10:11; 1 Pet. 4:7; 1 Jn 2:18; Rev. 22:20), whereupon there will be a transformation of the universe and 'new heavens and a new earth' (2 Pet. 3:13, Rev. 21:1; Rom. 8:19-23). The third chapter of the Second Epistle of Peter is especially rich in clues for the student of science and eschatology, in addition to those already mentioned, for example when it warns against the false assumptions of those who hold or 'want'

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52 Ross wrote under the pseudonym Frank Morison. His enquiry into the historicity of the resurrection was first published under the title *Who moved the Stone* in 1930 by Faber and Faber.

53 See Hume, D. *Enquiry*, sect. X, p. II, 94.

54 Duffin, J. *Medical Miracles: Doctors, Saints, and Healings in the Modern World*, New York: Oxford University Press (2009), p. 5.

55 *ibid.*, p. 183.

(θέλονταις – 2 Pet. 3:4-5) that nothing ever changes – one is inclined to think of the steady state cosmologists of all ages. Verse 10 is especially interesting for comparison with the scenarios of physical eschatology: the Greek original might be best translated ‘the heavens will pass away booming’ or ‘with a loud noise’ (ροιζήδον), while the same passage in the Latin Vulgate reads ‘magno impetu’, that is, ‘with a big thrust’ or ‘impulse’, or even ‘expansion’.

Some variation is to be found in the writings of the Church fathers, the great medieval theologians and right down to the theology of our time as to the relationship between the present world and the new creation. Some emphasise the continuity between the two, while others conceive of the transition between them more as a rupture.<sup>56</sup> Nevertheless, it appears to be a core element of Christian doctrine that it is this physical universe that will undergo a transformation at the end of time – as opposed to, say, eschatologies that affirm the existence of an afterlife alone, without any ultimate fulfilment of the universe. The Roman Catholic Church has reaffirmed this teaching in the context of the Second Vatican Council.<sup>57</sup> More recently, John Paul II expressed, in his letter to Rev. George Coyne, ‘a hope and assurance that the fragile goodness, beauty and life we see in the universe is moving towards a completion and fulfilment which will not be overwhelmed by the forces of dissolution and death’.<sup>58</sup> Of course, recent theology has also brought forth approaches that dispute that biblical eschatological scenarios have anything to do with the physical universe, some of which we will discuss in the next section. In any case, a complete dissociation between the two does not seem to square with the findings of biblical scholarship – in R. J. Russell’s words:

We cannot simply ‘write off’ eschatology as a pre-modern concern and then ‘de-mythologize’ the text (à la Bultmann) in order to focus clearly on the ‘real’ message of the New Testament. Instead, beginning with Albert Schweitzer’s quest for the historical Jesus and continuing in today’s biblical scholarship, we have discovered that the New Testament is irreducibly eschatological.<sup>59</sup>

### **What might the inputs from science, research on the mind-body problem, and theology imply for eschatology?**

Part of the difficulty in the dialogue between scientific and theological eschatology is that we are operating with two ‘epistemic modes’, so to speak, that is, those of prediction based on the laws of nature on the one hand, and hope due to a promise on the other, and the two cannot be directly compared or weighed

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56 See Bollini, C.R. *Evolución del Cosmos ¿aniquilación o plenitud?*, Buenos Aires: Epifania (2009).

57 Especially in *Lumen Gentium* 48, and *Gaudium et Spes* 39.

58 John Paul II. ‘Letter of His Holiness John Paul II. to Reverend George Coyne, S.J. Director of the Vatican Observatory’ (1988), online at [www.vatican.va/holy\\_father/john\\_paul\\_ii/letters/1988/documents/hf\\_jpii\\_let\\_19880601\\_padre-coyne\\_en.html](http://www.vatican.va/holy_father/john_paul_ii/letters/1988/documents/hf_jpii_let_19880601_padre-coyne_en.html)

59 Russell, R. J. *op. cit.*, (2), p. 274.

against each other. First and foremost, should the *ceteris paribus* assumption – according to which the universe will in the future be governed by the same laws as it is now, and we may therefore confidently extrapolate on the basis of these laws – be embraced, or rather challenged, either from the scientific side (e.g. through emergentist optimism, reference to the provisionality of scientific knowledge, or the more exotic scenarios in physical eschatology), or from the theological approach of *memoria futuri*? We are to a large extent ignorant of the future – though nevertheless equipped with some clues – but, especially in the context of Christian eschatology, cannot afford to remain silent about it. It seems that we have reason to reckon with a. *ceteris paribus* natural processes, perhaps along with new emergents in the natural world, but also catastrophic events, b. the shaping of the world through the minds of conscious beings by top-down causation, and c. divine action.

For the purposes of the relationship between scientific and theological eschatology, the scenarios of physical eschatology could be broadly divided into a. those that reckon with an infinite future, or predict a singularity in the far future, that is, when it is reasonable to expect that life will have become extinct, and b. those that feature singularities of various sorts in the comparatively near future, when life will still be around, or even the very near future.

There follows an analysis of views about the relationship between science and eschatology in contemporary literature ('eschatological options'), which will be evaluated in the light of the three main areas of research sketched out in the first part of this article. In addition, their eschato-practical implications will be discussed.

### **Eschatological options**

1. Physical eschatology falsifies theological eschatology. Perhaps most famously, this view was expressed by Bertrand Russell:

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 collocations 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 that the whole temple of man's achievement must inevitably be buried beneath the debris of the universe in ruins... Only within the scaffolding of these truths, only on the firm foundation of unyielding despair, can the soul's habitation henceforth be safely built.<sup>60</sup>

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60 Russell, B. 'A free man's worship', in *Mysticism and Logic, and Other Essays*, London: Allen Unwin (1963), p. 41, cited in Russell, R. J. *op. cit.*, (2), pp. 280-281. According to R.J. Russell, the passage was written in 1903.

Similarly, scientific predictions for the future of the universe have led Steven Weinberg to the conclusion that ‘the more the universe seems comprehensible, the more it also seems pointless.’<sup>61</sup>

Such and related arguments for cosmic despair are typically based on a combination of reductionism together with the prospect of thermodynamic heat-death, approximately on the following lines:

1. life, consciousness and the whole domain of meaning and values are reducible to physics and rely on complex structures of matter;
  2. but this complex matter is bound to decay, as we know from thermodynamics;
  3. therefore, the universe cannot really have a meaning.
2. Physical eschatology is compatible with theology’s notion of an eschatological goal of the universe, as long as one does not conceive of the eschaton literally as the end of time and the transformation of the physical universe, since such conceptions are ‘really not convincing any more’.<sup>62</sup> This position is mainly put forward by two groups of scholars: first, those who apply Whiteheadian process philosophy to eschatology.<sup>63</sup> The principle whereby ‘what matters to God now matters to God forever’<sup>64</sup> guarantees, according to process eschatology, the ultimate meaningfulness of the universe. For some of its proponents, this entails not only ‘objective immortality’ of the human person in the mind of God, but also ‘subjective immortality’, since ‘God’s prehension of our successive occasions of experience... effects their “resurrection” into the divine life’,<sup>65</sup> but process eschatology does not envision an end and transformation of the physical universe. The aim of eschatopraxis, then, is the Kingdom of God as a ‘political order for the world in which divine values – such as the golden rule... – could become the basis for policy’.<sup>66</sup>

The second group is of those who subscribe to the philosophy whereby theology and science are two different language games and therefore have ‘nothing, absolutely nothing to do with each other’.<sup>67</sup> For the relationship between science and eschatology this means, in the words of A. Benz, that ‘who trusts in me [Jesus], shares in the meaning of the whole, despite decay and death, even though the sun will burn up, the earth will get lost in space,

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61 Weinberg, S. *The First Three Minutes*, New York: Basic (1977), pp. 154-155, cited in Russell, R. J. *op. cit.*, (2), p. 281.

62 Bracken, J. (ed.) *World Without End: Christian Eschatology from a Process Perspective*, Grand Rapids: Wm. B. Eerdmans (2005), p. viii.

63 See Bracken, *op. cit.*, (62), and Griffin, D.R. ‘Process eschatology’, in Walls, J.L. *The Oxford Handbook of Eschatology*, New York: Oxford University Press (2010), pp. 295-309.

64 Cobb, J. ‘Is there a process eschatology?’ (2004), online at <http://www.processandfaith.org/askcobb/2004/12-ProcessEschatology.shtml>

65 Griffin *op. cit.*, (63), p. 299.

66 *ibid.*, p. 306.

67 Benz, A. *Die Zukunft des Universums: Zufall, Chaos, Gott?*, Munich: DTV (2001), p. 9. Benz attributes the saying to Karl Barth.

and the universe will radiate away'.<sup>68</sup> As with the process theologians, eschatology is about meaning, not physical transformation. Similarly, Kathryn Tanner proposes that theology abandon the doctrine that the world will have an end, in analogy to the doctrine of creation, where 'the world is the creation of God whether it has a beginning or not'.<sup>69</sup> By the same token, it is possible, according to Tanner, to have an 'eschatology without a future' grounded in the 'ongoing redemptive... relation to God that holds for the world of the past, present and future'.<sup>70</sup>

3. The future development of the cosmos will be cut short by divine action. Hence, those scenarios in physical eschatology that predict an infinite future, or those that predict singularities in the far future long after the disappearance of living beings, are correct *ceteris paribus*, that is, as an extrapolation, but will not come about, because God will intervene before. In J. Turl's words, these scenarios should then be regarded as a 'great might-have-been'.<sup>71</sup> A number of authors writing about the interface between science and eschatology subscribe to similar views. R. J. Russell has put it thus: 'the challenge is not technically from science but from a philosophical assumption which we routinely bring to science, namely that scientific predictions hold without qualification.'<sup>72</sup>

Two other thinkers who have reflected on the relationship between science and eschatology in recent years have reached similar conclusions: the Argentinean theologian Claudio R. Bollini, after a discussion of scientific predictions of the future of the universe and of Scripture and Christian Tradition, arrives at 'the confidence that the eschaton will happen before man disappears from the universe. We may propose, then, the hope that man in community will still find himself on pilgrimage in the history of salvation when the cosmic fulfilment occurs.'<sup>73</sup> Australian theologian D. Edwards is more reserved about the timing of the eschaton, but similarly to Bollini holds that:

if the theological idea of God's final transformation of creation is presumed to coincide with the far distant future of the universe, there is obviously a problem reconciling theological eschatology and scientific predictions. But there is no need to make this assumption. Theologically, we have a promise that the universe will be transformed and find its culmination in God. Theology has no information about when or how this will

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68 *ibid.*, p. 210.

69 Tanner, K. 'Eschatology without a future?', in Polkinghorne, J., Welker, M. (eds.) *The End of the World and the Ends of God*, Harrisburg: Trinity Press (2000), p. 224.

70 *ibid.*, p. 225.

71 Turl, J. *op. cit.*, (25), 139. Turl himself is critical of scenarios of cosmic discontinuity, as we shall see.

72 Russell, R. J. *op. cit.*, (2), pp. 306-307.

73 Bollini, C.R. *op. cit.*, (56), p. 256.

be... It is fundamental to remember that the resurrection of the crucified was not dependant on any obvious movement towards completion or perfection in the life and ministry of Jesus. Jesus' mission was interrupted by what seemed totally catastrophic.<sup>74</sup>

J. Turl, by contrast, is critical of any short-cutting of cosmic history by way of what he calls a 'cosmic guillotine'<sup>75</sup> because this would compromise the universe's natural, organic development. In his view, the vast spatio-temporal dimensions of the universe, and hence also a long future, may well have to do with the universe's being designed to accommodate several intelligent races, not just human beings. While eschatology for Turl does not require 'cosmological discontinuity', he does hold that the universe will reach an eschatological destiny when Christ returns, and the dead will be resurrected.<sup>76</sup>

4. Short physical eschatologies: the universe will end through natural causes during the time when there are still conscious living beings around. If the purpose of the universe is the emergence of such beings and the end of the development of the universe will happen during the time when these are still around, then Paul Davies' condition cited in the introduction of this paper, whereby the purpose and temporal end of the universe ought to coincide, is met. Of course, singularities in the near future do not by themselves assure the teleological character of the universe – for example, an eternally frozen porridge of subatomic particles, as in the 'Big Brake' models, is not much of a fulfilment – but it is significant for the present discussion that an end of the universe within the near future is no longer unthinkable in science.

But what is the relationship between such scenarios for singularities in the cosmic future and the theological notion of the end of the world? Do they coincide with it, the additional input from theology being that the singularity predicted by science will be followed by the transformation of the universe that Scripture speaks of? Or, by contrast, do they have nothing whatsoever to do with the theological eschaton, which depends on divine action, not natural processes? What is the role of second causes in eschatology according to theology? These issues are little explored, and further research is clearly needed. To my knowledge, among authors in science-eschatology only W. L. Craig at present draws a parallel between the eschaton which theology speaks of and one of the 'alternative' scenarios of physical eschatology, namely a phase transition of the universe through quantum tunnelling, although he is careful not to simply equate these two notions.<sup>77</sup>

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74 Edwards, D. 'Final fulfilment: the deification of creation' (2009), p. 9., online at [http://jpicformation.wikispaces.com/file/view/Denis+Edwards\\_3\\_en.pdf](http://jpicformation.wikispaces.com/file/view/Denis+Edwards_3_en.pdf). Italics in the original.

75 Turl, J. *op. cit.*, (25), 139.

76 *ibid.*, 159.

77 Craig, W. L. 'The end of the world', (after 2006, exact date unknown), online at [www.reasonablefaith.org/site/News2?page=NewsArticle&id=5533](http://www.reasonablefaith.org/site/News2?page=NewsArticle&id=5533)

5. The transformation of the universe will be brought about by living beings within it – not by divine action – in such a way that it will bloom with life forever, thus realising the Final Anthropic Principle. Most well-known among such scenarios are those proposed by Freeman Dyson<sup>78</sup> and Frank Tipler,<sup>79</sup> neither of which I will discuss here in any detail. Dyson’s model seems to be the more commendable one, since unlike Tipler’s it relies on the more likely scenario of an open universe, and features real living beings (albeit of a bizarre kind for us, such as great living dust-clouds), whereas Tipler has computer-simulated persons live in the happy subjective, and erroneous, impression of being immortal moments before the Big Crunch.<sup>80</sup>
6. Emergentist optimism: the history of the universe is marked by the emergence of ever more complex structures and qualitative novelties that could not have been predicted beforehand. It is therefore not irrational to hope for yet another interesting novelty in the future, whose nature is as yet unknown, and in whose birth we perhaps play a part. This argument is advanced both by non-theistic and by theistic authors. Among the former is Stuart Kauffman, who thinks there may be a ‘fourth law of thermodynamics’ by which ‘biospheres persistently increase the diversity of what can happen next’<sup>81</sup> and living beings through self-organisation continuously push forward into the ‘adjacent possible’.<sup>82</sup> For some authors, this provides an immanentist source of hope, as in L.B. Young’s *The Unfinished Universe*, which presents the universe as ‘an unfolding flower that has yet to bloom in its full glory’.<sup>83</sup> But some theistic writers have also challenged the cosmic pessimism often derived from thermodynamics by pointing to the emergence of novelty and unexpected, staggering complexity in the past history of the universe. According to C. Tresmontant,<sup>84</sup> the observed rises in complexity (such as the appearance of life on earth) are inexplicable through the laws of nature alone and point to an information source that must lie beyond the universe. The natural sciences can only provide us with information about the past and present of the universe, not the future, ‘except as concerns the processes of wearing-down and ageing’.<sup>85</sup> Knowledge of the purpose of the universe can then, for Tresmontant, in principle not be the object of science,

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78 Dyson, F. ‘Time without end: physics and biology in an open universe’, *Reviews of Modern Physics* (1979) 51(3), 447-60, as cited in Ellis, G.F.R. *The Far-Future Universe. Eschatology from a Cosmic Perspective*, p. 103, where this paper is reprinted.

79 Tipler, F. *The Physics of Immortality: Modern Cosmology, God, and the Resurrection of the Dead*, New York: Anchor Books (1995).

80 For an in-depth critique of Tipler’s scenario see Stoeger, W.R., Ellis, G.F.R. ‘A response to Tipler’s Omega-Point theory’, *Science & Christian Belief* (1995) 7(2), 163-172.

81 Kauffman, S. ‘The Emergence of Autonomous Agents’, in Gregersen, N.H. *From Complexity to Life*, Oxford: Oxford University Press (2003), p. 49.

82 *ibid.*, p. 70.

83 Thus P.C.W. Davies on the title page of: Young, L. B. *The Unfinished Universe*, New York: Oxford University Press (1986).

84 Tresmontant, C. *L’histoire de l’univers et le sens de la création*, Paris: Perrin (2007), pp. 205-216.

85 *ibid.*, p. 213.

but can only be made known by revelation. And in Pierre Teilhard de Chardin's thought, the vastness of space-time is complemented by the enormous complexity of living organisms we can witness on this planet – comparatively minute in size though these organisms be – so that he reasoned that, while the universe is expanding, there is also a 'tourbillon', a kind of vortex of growing complexity approaching the Omega Point.<sup>86</sup>

7. The universe will fall into ruins, but the souls of human beings, and perhaps other beings, will remain for ever.<sup>87</sup> Eschatology, then, is only about the afterlife and the realm of souls and spiritual beings, not about a physical transformation of the universe.
8. There are several levels of reality, separate and yet interrelated, and eschatology needs to take these into account. This, for example, is the stance of G. F. R. Ellis, who argues that several ontological realms or 'worlds' exist, interacting with each other and yet distinct from one another: roughly, the worlds of the physical universe, of living beings, of human consciousness, social life and values, of mathematics and the laws of nature, and finally, the 'world of God' as the locus where Platonic entities such as mathematical and moral truths reside. Since these entities beyond the physical universe have pre-existed it, it is reasonable to expect that 'what preexists will presumably remain in the future' – Ellis adds in the footnote that 'their effective presence in the universe will survive',<sup>88</sup> continuing to influence the universe even into the far future. This is reminiscent of Popper's cosmology, where the universe is divided into the three spheres: 'World 1' is the physical universe, 'World 2' is the 'psychological world', and 'World 3' is 'the world of products of the human mind', such as institutions, machines, books and libraries.<sup>89</sup> For Popper, the reality of all three worlds entails that the physical world is open to shaping by the realm of mind, but unlike in Ellis' world-view, there is no distinct realm for Platonic realities such as mathematical truths, laws of nature, and values, and Popper is agnostic as to the existence of God.

N. T. Wright and K. Heim envision a kind of joining together of the different realms in more supernaturalistic terms. In N. T. Wright's words, 'the promise is not that Jesus will simply reappear within the present world order, but that when heaven and earth are joined together in the new way God has promised, then he will appear to us – and we will appear to him... one day, the two worlds will be integrated completely and be fully visible to one another, producing that transformation of which both Paul and John speak.'<sup>90</sup> The German Lutheran theologian and early science-theology pio-

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86 Teilhard de Chardin, P. *Les directions de l'avenir*, Paris: Éditions du Seuil (1973), pp. 163-168.

87 According to the early science-theology pioneer K. Heim, German idealist philosopher Johann G. Fichte proposed such a view, although he gives no citation. See Heim, K. *Weltschöpfung und Weltende*, Hamburg: Furche-Verlag (1952), p. 170.

88 Ellis, G. F. R. *op. cit.*, (6), p. 350.

89 Popper *op. cit.* (4), p. 113-130.

90 Wright, N.T. *Surprised by Hope*, New York: Harper Collins (2008), pp. 134-135.

neer Karl Heim similarly held that the physical universe is encompassed by an unseen dimension, a 'space beyond polarity' ('überpolarer Raum' in German, by which Heim means a sphere beyond conflict and dialectical struggle). In Heim's picture, the universe originates in this realm, but has fallen away from it through the influence of evil forces. The eschaton, then, consists in the reintegration of both realms as the endpoint of a mutual approach.<sup>91</sup>

9. We do not know how physical and theological eschatology relate but, rather like Abraham (Gen. 15:1-6), are hoping for the fulfilment of the universe on the basis of a trustworthy promise, ignorant of how this will come about.

The work of J. C. Polkinghorne, one of the most prolific authors on the relationship between science and eschatology, needs to be treated separately, since his position does not appear to fall clearly into one of the eschatological options listed above. On the one hand, Polkinghorne regards it as certain that one of the scenarios of physical eschatology which predict very long futures (i.e. infinite expansion or Big Crunch) will come about.<sup>92</sup> As regards the individual's post-mortem destiny, he is critical of the traditional view of an intermediate state where the soul waits until the end of time (see Rev. 6:9-11), suggesting instead that 'we may all arrive simultaneously on the day of resurrection', which could be immediately after bodily death.<sup>93</sup> These passages fit in with the proposals under option 2. On the other hand, Polkinghorne sees presentist and process-theological approaches to eschatology as insufficient for Christian hope,<sup>94</sup> expects that the material universe, too, will participate in the new creation, and sees divine intervention to end the development of the universe as a possibility, albeit at a late stage<sup>95</sup> These elements in his thought come closer to option 3.

### ***Evaluation of the options***

Option 1 held that a scientific view of the future of the universe contradicts the ideas of meaning and ultimate fulfilment. If the ontological inventory attempted in the first part of this paper is not mistaken, it would seem that the reductionist premises upon which this position is based do not hold, especially concerning B. Russell's views of the mind-body problem, the accidental nature of life in the universe, and his determinist convictions, which seem, in the light of contemporary science, unfounded.

There are several problems with the inputs from process-theology and the philosophy of separate language-games as discussed under option 2: for one,

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91 Heim, K. *op. cit.*, (87), pp. 173-183.

92 Polkinghorne, J. *The God of Hope and the End of the World*, New Haven: Yale University Press (2002), pp. 8-9.

93 *ibid.*, pp. 121-122.

94 *ibid.*, pp. 98-100.

95 *ibid.*, p. 121, footnote.

these approaches postulate an ultimate meaningfulness for the universe, without this making any difference for its development, thus running into a complete isolation between the language-games of 'value' and of 'fact'. Not only does this seem rather facile, but it also leads to the admittance of a contradiction, for on the level of 'value' the universe will find an ultimate fulfilment, while on the level of 'fact' it is only heading towards its thermodynamic demise. Since everything follows from a falsehood, any claim could be made in a discourse that allows contradictory statements by reference to different language levels, and a rational discourse on eschatology would be impossible. P. Davies likewise is sceptical about the idea of 'meaning without goal', asking: 'Can there be true purpose in a project that is never completed? Can existence be meaningful if it consists of an unending journey toward a destination that is never reached?'<sup>96</sup>

The position of those process-eschatologists who admit an eschatological destiny for the individual ('subjective immortality') but not really for the cosmos seems to boil down to option 7, which has disembodied souls existing forever in a separate eschatological realm parallel to a decaying cosmos. This latter position is clearly an improvement compared to the dismal pessimism of Russell and Weinberg, and, given the irreducibility of the human mind as discussed earlier, can be regarded as a founded hope. However, the radical and ultimate divorce of the spiritual from the material dimensions of the human being does not seem to square with everyday experience or with what emerges from the study of mind-body relationship. Option 7 also drops the intimate connection between man and the cosmos, reducing the latter to a kind of launching pad for souls. The eschato-practical consequence of this view would be the necessity of care merely for the soul, but not for the body or the physical universe, since neither of these have an ultimate future anyway. And finally, such an eschatology does not square with Scripture or Christian doctrine, as we have seen.

These difficulties are avoided in the scenarios whereby living beings will transform the universe from within (option 5), especially in Dyson's scenario, since here, the physical universe reaches a kind of eschatological destiny, one brought about by its own inhabitants. Dyson's model does without sovereign divine action, and indeed in his view God is neither omniscient nor omnipotent but himself subject to evolution.<sup>97</sup> This can easily be seen to incur the philosophical problem that such a being could hardly be seen as an absolute ground of all that exists, capable of freely creating the universe, that is, as God, in the first place. Nor, of course, is it clear that the prospect of hibernating dust-clouds in the far future is much of a substitute for the Christian resurrection hope.<sup>98</sup>

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96 Davies, P. C. W. *op. cit.*, (5), pp. 154-155. Italics in the original.

97 Frankenberry, N. K. *The Faith of Scientists in Their Own Words*, Princeton: Princeton University Press (2008), p. 370.

98 See Turl, J. *op. cit.*, (25), 143.

The immanentist versions of emergence-based optimism (option 6) run into similar philosophical difficulties, and there appears to be no way how the hope that the universe will reach a fulfilment as a result of immanent processes alone can circumvent the challenge from thermodynamics – even Dyson’s vision is threatened by proton decay in the very far future. I suppose that these scenarios have arisen from the need to provide a basis for hope within a physicalist world-view, together with the implicit assumption of a closed and deterministic universe, where a hope that relies on ‘something beyond the universe’ is deemed unscientific.

This is not to say, however, that such speculative scenarios for the future of life in the universe have nothing to offer for an interdisciplinary approach to eschatology. If the future of the universe is long, then the prospect of life spreading through the cosmos and of our descendants migrating to other planets – though unthinkable in the near future due to the enormous distances and technical limitations – may be part of its meaning and eschatological significance. As M. Rees points out, this would not diminish the significance of the present age. On the contrary, if life in the universe is rare, or even unique to this planet, its potentially cosmic future may depend, for better or for worse, on our responsible stewardship.<sup>99</sup> These scenarios, wedded to a more robust philosophy and theology, could serve as a building block for eschatological hope, although because of the obstacles posed by the second law of thermodynamics and the philosophical problems associated with any purely immanentist hope, they cannot suffice on their own.

The various scenarios from authors who expect that the future will be cut short through divine action (option 3) avoid these difficulties, steer clear of reductionist philosophies, are capable of providing the foundation of an eschato-praxis which takes both the spiritual and corporeal dimensions of man at full value, and include an eschatological destiny for the physical universe. The expectation of future divine action is justified, as is a certain reserve about the reliability of scientific predictions. Since, however, we have argued that the open universe perspective does not mean predictions are meaningless (only limited), and since, furthermore, Scripture does seem to suggest that not only divine action, but also natural processes have a part in eschatology,<sup>100</sup> options that connect to the scenarios of physical eschatology seem preferable to those that affirm short-cutting of the natural process. This is the case in those versions of option four where the end of the world, as described by physics, is complemented by its fulfilment, as predicted by theology. But this, of course, presupposes that short-term physical eschatologies are correct, which we do not know.

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99 Rees, M. *Our Final Hour: A Scientist’s Warning*, New York: Basic Books (2004), pp. 157-168.

100 At least, this seems to be the case for the passages that address matter’s tendency to decay. I am not sure whether the sudden passing away of the heavens on the day of the Lord, as in 2 Pet. 3:10-12, & Isa. 34:4, is meant to be understood as a natural process or as a result of God’s intervention. More exegetical research seems required on this point.

The scenarios of the joining together of realms as envisaged by K. Heim and N. T. Wright (option 8) also include the physical universe and therefore seem to me to offer much for the eschatological discourse as well. Of course, all these options also raise many questions, as already pointed out, especially as to the relationship between direct divine action and the workings of secondary causes for eschatology. Perhaps interdisciplinary scholarship can make headway in a way analogous to the progress already made in the debate about the relationship between the Big Bang and the act of creation, by examining the respective inputs from physical eschatology, philosophy, Scripture, theology and the study of divine action. In this endeavour, robust philosophies, like those of Ellis and Popper discussed under 8, which take the richness of reality, its material and spiritual dimensions into account, thus avoiding both materialistic and idealistic reductionism, can guide and catalyse the encounter between the disciplines, safeguarding the discourse from all-too-easy answers or counsels of despair. The Abrahamic stance under option 9, founded as it is on God's promise and *memoria futuri*, rather than just a stab in the dark, can also guide us in eschatological thinking as an important part of mankind's way into the future. Might it be that in an open universe as described by Popper, heading towards a future that is at least in part intrinsically unknowable to its inhabitants, but is also co-constructed by them, such a stance, far from an expression of naive and unscientific thinking, is in fact the most consonant with the way the world is?

An afterthought: it may seem that the proposed interdisciplinary discourse on eschatology is of interest only for Christian theology (or religious thought in general), which therefore seeks to enter into dialogue with the natural sciences, while the latter have nothing to gain from such an encounter. A closer look will reveal that this is not so: rather, the picture that science itself provides us with, one of a universe that is open, emergent, featuring both bottom-up and top-down causation, rational but not fully predictable, gives the strong impression that interdisciplinary approaches to reality are preferable to reductionist ones, suggesting that the same holds true of eschatology. In addition, the question of the end of the universe is inseparably linked to the question of whether anything we do, including the improvement of the world through science, ultimately matters at all. It is now well known that the idea of a meaningful, rational universe has been crucial for the development of science. The German historian J. Fried argues that the same, as is perhaps less well known, can be said especially of eschatology.<sup>101</sup> Indeed, it is hard to see how we could meet the pressing challenges even of the near future if we subscribe to a view of cosmic futility based on reductionist philosophies. It seems rather that, 'Questions on the immensity of the universe, its origins and its end... do not admit of a scientific answer alone... only to the extent that they [i.e. science,

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101 See Fried, J. *Aufstieg aus dem Untergang: Apokalyptisches Denken und die Entstehung der modernen Naturwissenschaft im Mittelalter*, München: C.H. Beck (2001).

philosophy, and theology] succeed in entering into dialogue and in exchanging their respective competencies will they be able to present truly effective results to people today.<sup>102</sup>

Of course, interdisciplinary eschatology is about reasonable hope, not about prediction. There is a great asymmetry in principle between the discourse on the future and the study of the past, and we will not possess a definite answer to all this before the end of time itself. Nevertheless, as I have attempted to show, a rational discourse about the question ‘what may we hope’ is possible, and also necessary if we are to avoid falling for rash counsels of despair arising from reductionism. In this context, the open character of the universe, the divine promise of the new heavens and the new earth, and the possibility of discerning divine action in history which authenticates that promise, give us sufficient reason to affirm the traditional Judeo-Christian teaching of a future fulfilment of the universe. The wide range of areas of research involved in the enterprise of eschatological thought, from mathematics to the mind-body problem, from physical eschatology to the study of divine action, obviously necessitates the cooperation of researchers. It seems to me that the science-theology community is uniquely suited – *Deo adiuvante*, of course – to help humanity and the Church on its way into the future by shedding some light on this question. I am therefore grateful for any reactions, comments, and discussion on this article.<sup>103</sup>

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102 Benedict XVI. *Messaggio del Santo Padre Benedetto XVI all’Arcivescovo Rino Fisichella, Rettore della Pontificia Università Lateranense* (2009). online at: [http://www.vatican.va/holy\\_father/benedict\\_xvi/messages/pont-messages/2009/documents/hf\\_ben-xvi\\_mes\\_20091126\\_fisichella-telescopio\\_it.html](http://www.vatican.va/holy_father/benedict_xvi/messages/pont-messages/2009/documents/hf_ben-xvi_mes_20091126_fisichella-telescopio_it.html)

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