Editorial Introduction

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> [T]hough the medieval world was [...] immense, relatively to man and his planet, it was nevertheless definitely limited and fenced about. It was therefore essentially picturable; the perspectives which it presented, however great, were not wholly baffling to the imagination.[2]

> Copernicanism tore asunder the fit between the world and man's organs: the congruence between reality and visibility [...] The breakdown of the postulate of visibility – taken in its widest sense – is brought to a point by a kind of reversal: The visible world is not only a tiny section of physical reality, but it is also, qualitatively, the mere foreground of this reality, its insignificant surface, on which the outcome of processes and forces is only symptomatically displayed. Visibility itself is an eccentric configuration, the accidental convergence of heterogeneous sequences of physical events.[3]

Almost five hundred years after Nicolaus Copernicus' death, the notion of 'Copernicanism' continues to be a compelling one for science, philosophy and the popular imagination alike. However 'Copernicanism' stands for a

1. I would like to extend my thanks to Robin Mackay for his comments and contributions to this introduction, in particular the sections on the work of Nigel Cooke and Keith Tyson. Thanks also to Ray Brassier for his critical comments.

2. Arthur Lovejoy, *The Great Chain of Being* (Cambridge, Mass.,: Harvard University Press, 1936), 101.

3. Hans Blumenberg, *The Genesis of the Copernican World* (Cambridge, Mass.: MIT Press, 1987), 642.

legacy which is still contested, as the multiple perspectives collected in this, the fifth volume of **Collapse,** reveal; and as was amply demonstrated by some recent events.

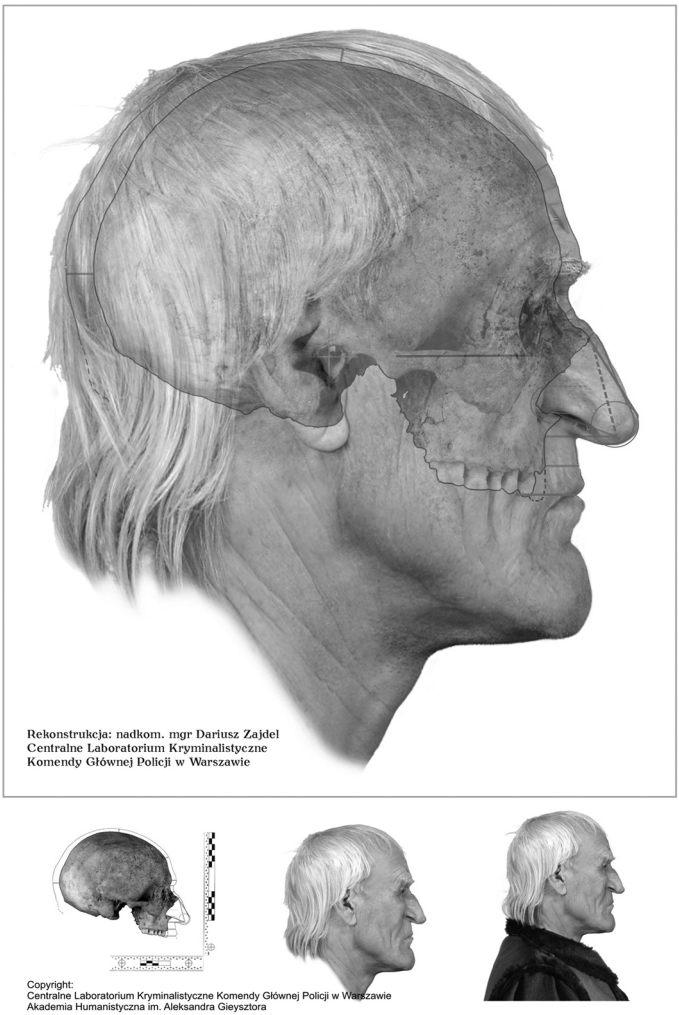
While in the penultimate stages of editing this volume in late November 2008, it was widely reported in the world's media that researchers in Poland had identified the remains of Nicolaus Copernicus by comparing DNA from a skeleton with that of a hair retrieved from one of the sixteenth-century astronomer's books. The findings, it was reported, were 'the culmination of four years of investigation and centuries of speculation about the final resting place of the man who challenged the Bible and medieval teachings of the church'.[4] The Catholic bishop who had instigated the archaeological search, however, knowing full well that Copernicus had never harboured any such heretical intentions, used the opportunity to point out that Copernicus had in fact been 'a deeply religious clergyman and cathedral canon who dedicated his main work to the Pope and presented his faith clearly'.[5]

The bishop of course neglected to mention the fact that it had taken no less than four and a half centuries and a succession of forty-four popes before one of latter took it upon himself to officially admit that Copernicus may actually have had a point.[6] Instead, he proposed that the discovery should lead humanity to reflect that centuries of conflict between scripture and empirical science had really

4. *The Guardian*, Friday 21 November 2008.

5. 'Bishop: Discovery of Copernicus' remains highlights his contributions', *Total Catholic*, 2 December, 2008.

6. 'Vatican Science Panel Told By Pope: Galileo Was Right', *New York Times*, 1 November, 1992.



Digital reconstruction of the head of Nicolaus Copernicus, on the basis of remains identified by Polish scientists in late 2008 as being those of the sixteenth-century astronomer.

only been a lot of fuss about nothing – a 'great misunderstanding' brought about by the fact that people had 'made the mistake of absolutising one philosophical vision without reflecting on new insights and discoveries'.[7] The implication, of course, was that no 'philosophical vision' ought to be so absolutised, and that we must finally come to understand that there is really no substantive conflict between science and Church doctrine at all – a conciliatory sentiment fittingly symbolised by the fact that Copernicus' remains, identified by means of advances made in late twentieth-century genetics and computer technology, are now set to be reinterred during the celebrations planned for Frombork Cathedral's 750th anniversary in 2010.[8] In thus ceremoniously returning Copernicus' remains to the consecrated grounds of this ancient place of worship, perhaps it is hoped that 'Copernicanism' itself, and the unholy forces it unleashed, might finally be buried as well.

Remarkably enough, this was not the only news report involving Copernicanism and the Catholic Church to appear during the final stages of the preparation of this volume. Just five days after the story about the identification of Copernicus' remains, *The Times* put out the headline 'Vatican Seeks to Rehabilitate Galileo Galilei', while *The Boston Pilot* ran with 'Vatican Official Says Galileo Was a Man of Faith'.[9] The occasion this time was the appearance of an article entitled 'Thank you, Galileo' on the front page of the Vatican's official newspaper, announcing a series of

7. 'Bishop', *Total Catholic*, op. cit.

8. Ibid.

9. *Times Online*, 26 November, 2008; *The Boston Pilot*, 5 December 2008.

events planned by the Vatican for 2009 to coincide with the celebrations surrounding the 400th anniversary of Galileo's first observations with a telescope. Earlier in 2008, Pope Benedict XVI had been obliged to cancel a planned visit to Rome's principal university due to vehement protests from academics and students who had accused him of hostility towards science, citing his alleged endorsement of the Inquisition's condemnation of Galileo. (In a speech in 1990, the then Cardinal Ratzinger had cited the philosopher of science turned anarchist-cum-Dadaist Paul Feyerabend's comment that the verdict against Galileo had been 'rational and just'.)[10] Given the negative press following from this incident, it seems that the Vatican had thought it expedient to publicly 'reclaim' Galileo for the Church, very much in the way that the Polish bishop had used the identification of Copernicus' remains as an opportunity to posthumously bring him back within the fold.

Citing Pope Benedict XVI's statement that Galileo had been 'a man of faith who saw nature as a Book written by God', the author of the Vatican's newspaper article reiterated the sentiment of the Polish bishop, insisting that the Galileo celebrations should 'encourage people to consider seriously the relationship between faith and science; lead scientists to recognize the role faith played in Galileo's life; and lead theologians to recognize the contributions Galileo made to the church's attitude toward science'.[11] Having announced

10. See, e.g., 'Pope pulls out of visit to Rome university after outrage at his views on Galileo and science', *The Guardian*, 16 January, 2008. The passage cited by Ratzinger is taken from Paul Feyerabend, *Wider den Methodenzwang*, 2nd ed. (Frankfurt am Main: Suhrkamp, 1983), 206. For helpful scholarly (rather than journalistic) treatment of the Feyerabend passage, and Ratzinger's citation of it, see Ernan McMullin, 'Quoting Feyerabend on Galileo', *Irish Theological Quarterly* 73, 2008: 164-73.

11. 'Vatican Official Says Galileo Was a Man of Faith', *The Boston Pilot*, op. cit.

in November that a statue of Galileo was to be erected in the Vatican gardens, the Pope then used the onset of the Winter solstice on the 21st of December as an opportunity to remark upon not only the coincidence of Christmas with the solstice and 'the function of astronomy in marking out the rhythm of prayer', but to once again praise Galileo and his telescope for the way in which they had stimulated appreciation of God's work: 'If the heavens', said the Pope, 'according to the beautiful words of the psalmist, "proclaim the glory of God" (Psalm 19 [18]: 2), then the laws of nature, which over the course of the centuries many men and women of science have helped us to understand better, are also a great stimulus to contemplate with gratitude the works of the Lord.'[12] One can only surmise what the official Vatican line will be with respect to the imminent celebrations for the 200th anniversary of Darwin's birth and the 150th anniversary of *The Origin of Species* in 2009. Will it be claimed that Darwin too had been a 'man of faith', and that evolution likewise bears witness to the glory of the Lord's Creation?[13]

Of course, that Nicolaus Copernicus and Galileo Galilei were 'men of faith' is uncontroversial. Indeed, given that the Pope's comments were made in connection with the quatercentenary of Galileo's first use of the telescope, he

12. See the news headlines for 21 December 2008: 'Pope Praises Galileo's Astronomy' (*BBC News*), 'From Heretic to Hero: Pope Pays Tribute to Galileo' (*ABC Online*), 'Pope Benedict XVI Celebrates Galileo's Astronomy' (*The Télegraph*).

13. Given the fact that in April 2007 Pope Benedict gently 'corrected' Pope John Paul II's 1996 statement that evolution was 'more than a hypothesis', stating that while his predecessor 'had his reasons for saying this, it is also true that the theory of evolution is not a scientifically proven theory', this seems rather less than likely. See 'Pope Stokes Debate on Darwin and Evolution', *Times Online*, April 12, 2007.

might have done well to point out that, in his 1610 *Sidereus nuncius* (i.e., the book in which his first telescopic observations were reported), Galileo had enthusiastically declared that he had devised the telescope 'after being illuminated by divine grace.'[14] Moreover, as Hans Blumenberg and Karsten Harries have documented, the advent of the telescope in the seventeenth century was seized upon by the likes of Francis Bacon and Joseph Glanvill as an invention which promised a technological restitution of the perfect clarity of vision which humanity had supposedly lost with Adam's fall. Adam, surmised Glanvill,

> needed no Spectacles. The acuteness of his natural Opticks (if conjecture may have credit) shew'd much of the Coelestial magnificence and bravery without a Galilaeo's tube: And 'tis most probable that his naked eyes could reach near as much of the upper world, as we with all the advantages of art. It may be 'twas as absurd even in the judgement of his senses, that the Sun and Stars should be so very much less than this Globe, as the contrary seems in ours; and 'tis not unlikely that he held as clear a perception of the earth's motion, as we think we have of its quiescence.[15]

Glanvill's book was published just fifteen years before Olaf Römer's discovery of the finite speed of light in 1676 – a discovery scarcely less momentous than that of the

14. 'All these facts were discovered by me not many days ago with the aid of a spyglass which I devised, after being illuminated by divine grace.' Galileo Galilei, *The Starry Messenger*, in *Discoveries and Opinions of Galileo*, trans. S. Drake (New York: Anchor Books, 1957), 28.

15. Joseph Glanvill, *The Vanity of Dogmatizing* (1661), cited in Harries, *Infinity and Perspective*, op. cit., 106. On seventeenth-century attitudes toward both the telescope and microscope, see also Catherine Wilson, *The Invisible World: Early Modern philosophy and the Invention of the Microscope* (Princeton: Princeton University Press, 1995).

Copernican revolution itself, and which was later adverted to in Mark Twain's posthumously published *Letters from the Earth*, wherein Satan, in one of the most cruelly cynical tirades against human vanity ever written, points out that at the beginning of Creation not even a single star would have been visible in the sky over the biblical Paradise, and that even at the end of a thousand years there still would not have been enough to 'make a show'.[16] Yet as Blumenberg suggests, Bacon's idea of making the recovery of Paradise into the goal of historical progress through science, and Glanvill's expectation that the telescope might ultimately enable man to recoup his prelapsarian intuitive prowess, should be understood less as the secularisation of an originally religious idea and more as a way of safeguarding an anthropology in which man and cosmos are seen as 'coordinated in such a way that no essential incongruence can be assumed between man's organic equipment and the constituents of reality'.[17] No wonder, then, that Bacon, the anti-Copernican, expressed such alarm at the idea of the finite speed of light:

> It seemed to him shocking (*dubitatio plane monstrosa*) that in looking at the starry heavens we could catch sight only of the past, something that might have long since ceased to be real – that the *tempus visum* and *tempus verum* [apparent time and true time] could split apart arbitrarily [...] that the presentation of the starry heavens, which man had so long related to himself as the one who was called to observe it, could be a mere appearance

16. Mark Twain, *Letters from the Earth* (New York: Harper & Row, 1962), 15. Twain wrote the book in 1909; it was not published until 1962.

17. *The Genesis of the Copernican World*, op. cit., 629, cf. 635 and Part VI, Chapter 1: 'How Horizons of Visibility Are Conditioned by Views of Man', 622-642 *passim*.

also in that it was not the homogeneous total reality that it presents itself as in intuition, but instead was nothing but an accidental section through the many layered depths of huge temporal differences.[18]

According to Blumenberg, the epochal significance not only of Copernicanism but also of what we might call 'Römerianism', is thus not so much that it entailed 'man's removal from the centre',[19] but rather that it rendered obsolete once and for all the medieval equation of reality and visibility,[20] thus revealing a seemingly unbridgeable chasm between our biologically-inherited perceptual faculties and the sheer scale and complexity of the universe. While Copernicus himself could still employ as a premise in arguing for the truth (rather than mere empirical adequacy)

18. Ibid., 542.

19. As scores of historians have not failed to point out, this standard narrative is inherently implausible inasmuch as the medieval conception of the cosmos was less anthropocentric than *diabolocentric*, the earth being regarded as 'the filth and mire of the world, the worst, lowest, most lifeless part of the universe, the bottom story of the house' (Montaigne as quoted by Arthur Lovejoy, *The Great Chain of Being*, op. cit., 102) and the actual centre of the universe being identified with hell. As late as 1640 an English supporter of Copernicanism recognised one of the strongest current arguments against heliocentrism as proceeding from 'the vileness of our earth, because it consists of a more sordid and base matter than any other part of the world; and therefore must be situated in the centre, which is the worst place' (ibid.). Galileo himself, in the work already cited, took himself to be furnishing a refutation of 'those who argue that the earth must be excluded from the dancing swirl of stars for the specific reason that it is devoid of motion and of light. We shall prove the earth to be a wandering body surpassing the moon in splendor, and not the sink of all dull refuse of the universe; this we shall support by an infinitude of arguments drawn from nature' (*The Starry Messenger*, op. cit., 43). Thus, from the perspective of pre-modern cosmology and theology, Copernicanism, far from entailing the *demotion* of the earth and of man, actually amounted to their *exaltation*. For a brief but helpful survey of the evidence, see Dennis Danielson, 'The Great Copernican Cliché', *American Journal of Physics* 69 (1), 2001: 1029-35.

20. This is what Blumenberg calls 'the postulate of visibility' in our epigraph.

of his theory the idea that the universe had been created 'on our behalf' or 'for our sake' (*propter nos*) by a supremely good and orderly Creator,[21] such a teleological, anthropocentric conception of the universe became increasingly difficult to maintain in the wake of Römer's demonstration of the finite speed of light – that is, at least, for those who were cognizant of its implications. How, after all, could one continue to regard man as the privileged *contemplator caeli*, as the specially appointed witness of the wonders of creation, when the time required for the light to reach him from unknown star systems was longer than the entire duration of the earth?

In this regard, the fact that UNESCO elected 2009 as the International Year of Astronomy on the grounds that it is the 400th anniversary of Galileo's first telescopic observations speaks volumes with regard to what Blumenberg called 'man's optical neediness',[22] and is symptomatic of the extent to which we are still in thrall to what Popper called 'the Baconian myth' – that is, the idea 'that all science starts from observation and then slowly and cautiously proceeds

21. In the Preface to *De Revolutionibus*, Copernicus states that the reason he set out to see if the assumption of a moving Earth would provide better explanations of celestial phenomena was that he had been 'annoyed with the philosophers, who while in other respects had made a very careful scrutiny of the least details of the world, had discovered no sure scheme for the movements of the machinery of the world, which was built for us by the Best and Most Orderly Workman of all' (*On the Revolution of Heavenly Spheres*, in [ed.] Stephen Hawking, *Standing on the Shoulders of Giants: The Great Works of Physics and Astronomy*, London & New York: Penguin Books, 2002, 10). The seeming paradox of this unequivocal statement of teleological anthropocentrism ('built for us' or 'on our behalf') as the motivating reason for the Copernican revolution is examined at length in Blumenberg's *The Genesis of the Copernican World*, op. cit.

22. Blumenberg, *The Genesis of the Copernican World*, op. cit., 632.

to theories'.[23] Galileo's telescopic observations – observations which first made visible the moons of Jupiter, the ring of Saturn, the phases of Venus, and the craters and mountains of the moon – were certainly of great scientific and historical significance. However, 1609 witnessed another breakthrough in astronomy which was even more portentous, yet which has not even so much as been mentioned in relation to the forthcoming quatercentenary celebrations: namely, the publication of Kepler's *Astronomia nova*. Not only did this book lay the very foundations of modern astronomy and physics, but it did so on the basis of precisely that kind of resolute refusal to be taken in by the self-evidences of sensible intuition which Galileo professed to so admire in Copernicus.[24] Indeed, in comparison with Kepler's break with tradition in abandoning the 'Platonic' requirement that all celestial orbits be circular, Galileo's telescopic observation of the Jupiter system 'seems extremely conventional [...] an attempted *coup de main* of intuition, by means of the telescope, to carry the day for Copernicanism', with Galileo's medieval faith in what he

23. Karl Popper, *Conjectures and Refutations* (London and New York: Routledge, 1963), 185.

24. In his *Dialogue Concerning the Two Chief World Systems*, in response to Sagredo's expression of surprise that Pythagoreanism 'has found so few followers in the course of centuries' and that 'even Copernicus is not having any better luck with it in these latter days', Galileo-Salviato replies: 'No, Sagredo, my surprise is very different from yours. You wonder that there are so few followers of the Pythagorean opinion, whereas I am astonished that there have been any up to this day who have embraced and followed it. Nor can I ever sufficiently admire the outstanding acumen of those who have taken hold of this opinion and accepted it as true; they have through sheer force of intellect done such violence to their own senses as to prefer what reason told them over that which sensible experience plainly showed them to the contrary.' (This quotation is from the Third Day of Galileo's *Dialogue Concerning the Two Chief World Systems* [1632]; the English translation of the full text by Stillman Drake is available online at http://www.law.umkc.edu/faculty/projects/ftrials/galileo/dialogue.html.)

called 'the certainly of sense evidence'[25] blinding him to the momentous achievements of Kepler.

The idea that direct, first-person observation provides not only the ultimate *source* of knowledge but also its *fulfilment*, that reason and theory are only ever an anticipation of intuition (the latter being regarded as the very essence of a fully realised relation to reality), is one that has very deep roots in Western philosophy. Indeed, it is one which governs the traditional historiography of science whenever the demise of the Aristotelian philosophy of nature is attributed to the latter's allegedly speculative, non-empirical stance, being superseded by a thoroughly empirical approach to science. But on the contrary, as Blumenberg suggests, the downfall of Aristotelian physics is better described by the lapidary sentence of Heinrich Scholz: 'It perished as a result of its positivism'.[26] It is well known that the Aristotelian physics is in fact very close to the commonsense 'folk physics' of everyday experience, and 'is familiar to us in a way that Galileo's and Newton's never can be'.[27] What was needed to overcome the Aristotelian philosophy of nature was not simply more experience, or greater attention to the way things appear, but rather a different *kind* of experience, 'an experience which was already directed toward specific premises – selected and arranged in accordance with them – and placed under definite conditions: in other words, *experimental* experience':

25. Galileo Galilei, *The Starry Messenger*, op. cit., 28.

26. Blumenberg, *The Genesis of the Copernican World*, op. cit., 394.

27. Lewis Wolpert, *The Unnatural Nature of Science* (Cambridge, Mass.: Harvard University Press, 1991), 3.

> This type of experience never presents itself immediately, and is not exhausted in intuitive givenness. It confirms or disproves assumptions in regard to a definite and, at least in principle, measurable aspect of a total phenomenon. Experience that is controlled – not to say prepared or dissected – in this way cannot stand at the beginning of radical theoretical change. Instead, what stands at this beginning is a distancing from the immediacy of the life-world.[28]

It was precisely this transformation of the notion of experience that Kant recognised as the revolution which placed the study of nature 'on the secure path of a science', and upon which he modelled his own 'transcendental' revolution in metaphysics:

> When Galileo caused balls, the weights of which he had himself previously determined, to roll down an inclined plane; when Torricelli made the air carry a weight which he had calculated beforehand to be equal to that of a definite volume of water; or in more recent times, when Stahl changed metal into lime, and lime back into metal, by withdrawing something and then restoring it, a light broke upon all students of nature. They learned that reason has insight only into that which it produces after a plan of its own, and that it must not allow itself to be kept, as it were, in nature's leading-strings, but must itself show the way with principles of judgement based upon fixed laws, constraining nature to give answer to questions of reason's own determining. Accidental observations, made in obedience to no previously thought-out plan, can never be made to yield a necessary law, which alone reason is concerned to discover.[29]

28. Blumenberg, *The Genesis of the Copernican World*, op. cit., 394.

29. Immanuel Kant, *Critique of Pure Reason*, trans. N. K. Smith (London: Macmillan, 1929), Bxii-xiii.

While one might agree with Popper that Kant's statement that '[o]ur intellect does not draw its laws from nature [...] but imposes them upon nature' must be modified as 'but tries – with varying degrees of success – to impose upon nature laws which it freely invents',[30] Kant's statement is significant for its recognition of the way in which the history of science refutes the Baconian myth that all science starts from pure observation. Once modified in the way suggested, one ends up with Popper's notion of science as the forwarding of risky conjectures and bold speculations which, while they may be 'in striking contrast to the everyday world of common experience', are 'yet able to explain some aspects of this world of common experience'.[31] This is a tradition to be valued for 'its ability to free our minds from old beliefs, old prejudices, and old certainties, and to offer us in their stead new conjectures and daring hypotheses'.[32] Such speculatively audacious attempts to '*explain the known by the unknown*' have immeasurably extended the realm of the known, adding to the facts of our everyday world 'the invisible air, the antipodes, the circulation of the blood, the worlds of the telescope and the microscope, of electricity, and of tracer atoms showing us in detail the movements of matter within living bodies'.[33]

It is precisely this willingness to question and even radically overturn the commonsense or intuitive image of the world that **Carlo Rovelli** identifies as the essence

30. Popper, *Conjectures and Refutation*, op. cit., 259; emphasis added.

31. Ibid., 137.

32. Ibid., 136-7.

33. Ibid.

of the scientific enterprise in the first essay of the present volume, 'Anaximander's Legacy'. Drawing upon both his extensive historical erudition and his first-hand experience of research at the cutting-edge of contemporary theoretical physics, Rovelli meditates on the question 'What is Scientific Thinking?' and takes us on a tour through some of the most profound conceptual revolutions of the history of science. As one of the founders of loop quantum gravity – today widely recognized as the leading rival to string theory in the quest to unify general relativity and quantum mechanics – there is scarcely anyone alive today in a better position to reflect upon the counterintuitive nature of modern science than Rovelli. Providing as it does a stimulating overview of the way in which science continually 'redraws the image of the world' based on its perpetual 'rebellion against what appears obvious', Rovelli's essay is a fitting introduction to the 'Copernican imperative' to which this volume of **Collapse** is devoted.

By all accounts, Anaximander's studies were vast in scope, comprising a cosmogony, a history of the earth and the heavenly bodies, a proto-Darwinian account of the development of living organisms and the origin of species, studies in astronomy, meteorology and biology, a geography, as well as the first attempt to describe the structure of the universe in mathematical terms. But it was Anaximander's conjecture that the earth 'is held up by nothing, but remains stationary owing to the fact that it is equally distance from all other things'[34] that Rovelli singles out as the 'gigantic leap in our understanding of the world' which set in motion the naturalistic inquiry that

34. Quoted in Popper, *Conjectures and Refutation*, op. cit., 186.

ultimately evolved into modern science. Popper described this hypothesis as 'one of the boldest, most revolutionary, and most portentous ideas in the whole history of human thought',[35] and it is not hard to see why. While every account of which we have a record, including that of Anaximander's teacher Thales, pictures the earth as resting upon some support or other, Anaximander boldly conjectures, against the evidence of sense experience, that the earth is suspended in mid-space. Faced with the mutually contradictory commonsense beliefs that everything moves downwards, and yet that the earth is at rest, Anaximander in effect accepts the latter of these conflicting judgments and rejects the application of the former to the earth, and he does so on the basis of considerations of symmetry and geometrical structure. In short, Anaximander's ingenious answer to the conflicting judgements of common sense amounts to the first application of the Principle of Sufficient Reason of which we have any trace the history of thought: The earth does not fall, conjectures Anaximander, because has no *reason* to move in one direction rather than other. As Rovelli suggests, Anaximander's willingness to reject observation-based judgements in favour of mathematical and logical considerations in constructing his theory amounts to the invention of a completely new grammar for understanding the spatial structure of the universe, one in which the idea of *absolute direction* is abolished. By 'subverting the meaning of "up" and "down", which had provided the most intuitive and elementary way of organizing space and reality for countless generations of humans hitherto', Anaximander 'inaugurates the very process of *rethinking the*

35. Popper, *Conjectures and Refutation*, op. cit., 186.

image of the world – the path of investigation of the world which is based on the rebellion against what is obvious' that is characteristic of the scientific enterprise.

How did Anaximander arrive at this remarkable theory? 'Certainly not', writes Popper, 'by observation'[36] but rather by critical engagement with his predecessor Thales – a type of critical engagement which, as Rovelli also suggests, seems to have been invented by the Ionian school. Thales founded a new school in which there was a new relation between master and pupil, one in which the former tolerated, perhaps even encouraged, criticism, one generation after another. It would be difficult to exaggerate the momentousness of this innovation in the history of human thought, representing as it does a break with dogmatic tradition and an admittance of a plurality of competing doctrines which all try to approach the truth by means of critical discussion. As Popper points out, this leads almost by necessity to the realization 'that our attempts to see and to find the truth are not final, but open to improvement; that our knowledge, our doctrine, is conjectural; that it consists of guesses, of hypotheses, rather than final and certain truths; and that criticism and critical discussion are our only means of getting nearer to the truth'.[37] This is a sentiment also strongly endorsed by Rovelli, according to whom it is the Ionian school's 'realization that we can have *valuable* knowledge, but at the same time that this knowledge can be partially wrong' that 'opens up the path for the immense development of subsequent speculation, which is the basis of Greek philosophy and modern science'.

36. Ibid., 187.

37. Ibid., 203.

According to Rovelli, today we are 'in the midst of a reconceptualization of our world which is likely to prove every bit as far-reaching as those of Anaximander and Copernicus'. The revolutions of twentieth-century physics, if properly digested, entail 'a change of image of the world far more dramatic than that of Copernicus, and also a change of image of ourselves far more far-reaching than Darwin'.[38] Perhaps most dramatically, Rovelli predicts that we will discover that space and time do not exist at the most fundamental level, that they are in effect a reflection of our ignorance, 'convenient macroscopic approximations, flimsy but illusory and insufficient screens that our mind uses to organize reality'.[39] Moreover, he predicts that we will have to give up the notion that there are 'things' altogether, in favour of a way of thinking about nature that 'refers only to interactions between systems and not to states or changes of individual systems'[40] – an idea also ultimately prepared for by Anaximander's 'gigantic leap', and one which is has a strong affinity with those defended by Julian Barbour, James Ladyman and Gabriel Catren, also in this volume.

38. *Edge: World Question Center*, Annual Question 2006: 'What is Your Dangerous Idea?', online at http://www.edge.org/q2006/q06_print.html#rovelli.

39. *Edge: World Question Center*, Annual Question 2005: 'What Do You Believe is True Even Though You Cannot Prove it?, online at http://www.edge.org/q2005/q05_2.html#rovelli.

40. Ibid. For detailed treatment of these ideas see for example Carlo Rovelli, *Quantum Gravity* (Oxford: Clarendon Press, 2003); Carlo Rovelli, 'Halfway Through the Woods: Contemporary Research on Space and Time' in J. Earman & J. Norton (eds), *The Cosmos of Science* (Pittsburgh: University of Pittsburgh Press, 1997), 180-223; and 'Quantum Spacetime: What do we know?' in C. Callender and N. Huggett (eds), *Physics Meets Philosophy at the Planck Scale* (Cambridge: Cambridge University Press, 2001), 101-22.

The question Rovelli raises towards the end of his paper – namely, '*Is it possible to think a world without time?*' – is one that has preoccupied theoretical physicist and historian of physics **Julian Barbour** for the best part of five decades. Like the great philosopher-physicists of a century ago such as Ernst Mach, Henri Poincaré and Pierre Duhem, Barbour is not only a physicist but also an eminent historian of science, and it is clear that the breakthroughs he has been able to make in rethinking the foundations of physics are owed in no small part to his considerable historical and epistemological erudition. Having sacrificed a promising career in academia in order to devote himself to exploring his interest in dynamics unencumbered by the 'publish-or-perish syndrome', Barbour set himself the task of a fundamental rethinking of two basic questions that he felt had seldom been seriously asked, let alone satisfactorily answered: 'What is time?', and 'What is motion?' These are precisely the two questions that Leibniz and Mach had raised in their critique of Newton's absolute concepts, but had not answered definitively, and Barbour's entire adult life has been devoted to resolving them. In our interview we discuss with him the way in which his early reading of Mach provided a crucial stimulus to his life's work, ultimately leading him to the most counterintuitive conclusion imaginable: namely, that time *does not exist*. This is of course not a thesis which anyone is likely to take on trust, and in our interview Barbour not only recounts the motivations and influences that led him to embrace it, but also responds to some of the inevitable criticisms that have been voiced in connection with it. Of all the commonsense-defying ideas to be encountered in this volume, Barbour's

are surely the most difficult to intuitively digest; and yet, as the reader will discover, they are also ideas to which those working in the most advanced areas of contemporary quantum gravity research, whether it be string theory or loop quantum gravity, are increasingly being drawn.

The problem of the relationship between a mathematicized reality and a human intuition which persists in asking 'how to make sense of this?' is also explored, visually and conceptually, in a unique collaboration between artist **Conrad Shawcross** and philosopher **Robin Mackay** in 'Shadows of Copernicanism'. As Mackay suggests, Shawcross's remarkable 2006 work *Binary Star* provides a potent visual challenge to the heliotropic tendency of the philosophical imaginary, an imaginary in which the sun has always stood as the metaphor for a singular *lumen naturale*, a unique source of enlightenment. For Mackay, *Binary Star* raises questions regarding the philosophical tradition's metaphorical anchorage of thought to apparently fixed and permanent characteristics of the physical world. If Rovelli suggests that the search for 'a fixed point on which to rest is [...] naïve, useless, and counterproductive for the development of science'[41] and Barbour's theory demands that we 'learn how to find our bearings when the solid reassuring framework of the Earth is not there',[42] Mackay suggests that the challenge of philosophical thought today amounts to coming to terms with a scientific worldview 'which disabuses us of every illusion of fixity and permanence'. In this regard, Shawcross's *Binary Star*

41. 'Quantum Spacetime: What do we know?', op. cit., 121.

42. *The End of Time*, op. cit., 71.

demonstrates how the 'Copernican cliché' of a 'reversal of perspective between two heavenly bodies' remains tied to 'terrestrial' tropes of thought. If Tycho Brahe's destruction of the crystal spheres prompted Kepler to remark (as quoted by Barbour in our interview) that '[f]rom now on, the planets must find their way through the void like birds through the air' – a remarkably prescient comment in view of the recent discovery of enormous numbers of planet-sized bodies roaming freely in the void between the stars[43] – the physical picture of the world furnished by general relativity is one in which localisation with respect to a background spacetime, or to any fixed external reference system, has no meaning. Mackay suggests that art, given to the image and what is humanly intuitable, insistently inhabits the terrain of this fractured ground, of the gap opened up between mathematical models freed from the contingencies of human visibility and the efforts of intuition and the imagination to make sense of them; and that Shawcross's works mimic the efforts which philosophy must make to incorporate mathematical-scientific models of reality into the grain of language without ceding the latter entirely to mathematical abstraction. Thus the most profound content of the work, suggests Mackay, lies in a vacillation between object and model that indexes its necessary 'failure'.

The idea that there exists an intimate correlation between reality and visibility, or between the actual and the intuitable, is not one which was left behind with the Middle Ages. Rather, it is one which remains deeply rooted in the

43. See, e.g., P. W. Lucas & P. F. Roche, 'A population of very young brown dwarfs and free-floating planets in Orion', *Monthly Notices of the Royal Astronomical Society* 314 (4), 2002: 858-64; and H. Cheongho, 'Secure Identification of Free-floating Planets', *The Astrophysical Journal* 644 (2), 2006: 1232-6.

human psyche. Not only for the first-person perspective of common sense, for which degrees of phenomenal availability are experienced as degrees of 'realness',[44] but even for significant numbers of contemporary philosophers, 'reality' and 'manifestation' are treated as highly correlative concepts, often even being employed interchangeably. While traditional empiricist and positivist philosophies took the limits of the real to coincide with the boundaries of the (humanly) observable, many self-styled 'critical' philosophers – philosophers, that is, who typically pride themselves upon their overcoming of the 'naïveté' of positivism – continue to persist in the opinion that phenomenology is ontology enough. While earlier philosophers, beginning with Kant, based their critical inquiries upon an extensive familiarity with the best scientific knowledge of their times, many contemporary philosophers, perhaps daunted by the vast and highly-specialised edifice of contemporary science, seem to believe that they can afford to forego the difficult task of acquainting themselves with the methods and results of the sciences altogether.

However, as **James Ladyman** makes clear in our interview 'Who's Afraid of Scientism?', it is not only philosophers working in the Continental tradition who are guilty of such negligence. According to Ladyman and Don Ross in their recent book *Every Thing Must Go: Metaphysics Naturalized*,[45] many of the standard debates in contemporary analytic metaphysics – debates concerning, for

44. Thomas Metzinger, *Being No One: The Self-Model Theory of Subjectivity* (Cambridge, Mass.: MIT Press, 2004), 75.

45. James Ladyman and Don Ross with David Spurrett and John Collier, *Every Thing Must Go: Metaphysics Naturalized* (Oxford: Oxford University Press, 2007).

example, causation, identity, part-whole relations, and the nature of time – typically involve little more actual science than was available to the early modern philosophers, or even the pre-Socratics.[46] In this regard, what today passes for metaphysics, whether in the Continental or analytic tradition, amounts to a continuation of what Ladyman and Ross call 'the metaphysics of domestication', a tradition 'which aims at domesticating scientific discoveries so as to render them compatible with intuitive or "folk" pictures of structural composition and causation'.[47] While such efforts at domestication are typically defended on the grounds that they provide *understanding* (read: 'rendering more familiar'), in contrast to science itself, which allegedly allows only for *explanation*, Ladyman and Ross argue that such metaphysics cannot be defended 'on the grounds that psychological repose and cultural familiarity are values that might be defended against the objective truth'.[48] However much 'the objective truth' might always be open to revision and correction, such refinement and extension of our knowledge is itself a process which is *internal* to the ongoing project of science itself, and not something that might be achieved by adopting an imaginary stance of philosophical anteriority floating entirely free of the sciences.

In our interview, Ladyman expresses his exasperation with philosophers unable or unwilling to abandon the constraints of intuition and the manifest image, and who stubbornly insist upon pursuing metaphysics as if modern

46. Ibid., 20.

47. Ibid., 1 and Chapter One *passim*.

48. Ibid., 4.

science had never happened. While many philosophers habitually decry any philosophical position that goes beyond a vague science-friendliness as 'scientistic', Ladyman argues forcefully for a radically naturalistic metaphysics based upon what he and Ross have provocatively called 'the scientistic stance'. As well as explaining why he believes it is incumbent upon philosophers to free themselves from the parochial conceptual prejudices devolving from an uncritical embrace of categories rooted in the manifest image, Ladyman also challenges the all too popular *doxa* that would align science with ideological conservatism. While some philosophers may still dream of 'some kind of new age spirituality that will re-enchant nature, de-alienate us and inaugurate some kind of postmodern arcadia', Ladyman argues that 'the actual alternatives to science are the ideologies of bigotry and superstition'.

As one of the leading voices in current debates in the philosophy of science, Ladyman has developed, along with Steven French, a distinctive brand of scientific realism he calls 'ontic structural realism', a position that would synthesize the virtues of empiricism and realism by denying the ontological priority of individual objects and properties in favour of the primacy of relational structures. While structural realism in the philosophy of science goes back at least as far as Henri Poincaré a century ago, Ladyman's position is distinctive inasmuch as it construes structural realism as a metaphysical rather than as a merely epistemological thesis. In other words, while Poincaré held that all that we can *know* are the structures of or relations holding between inscrutable objects in themselves, Ladyman argues that these structures are *all that there is*, thus closing the

gap between epistemology and metaphysics entailed by Poincaré's quasi-Kantian position. Motivated as it is not only by the problem of theoretical change in the history of science, but also by reflection upon quantum mechanics and general relativity, one might expect that Ladyman's eliminativism with regard to individual objects and intrinsic properties entails a reductive physicalism. However, the project developed in *Every Thing Must Go*, whilst granting to physics a definite epistemological and ontological priority, aims at a unification of the sciences which proceeds by way of consilience rather than reduction. But how is it possible to defend a physics-based metaphysics which holds that there are no such things as 'things' without impugning the reality of the everyday lifeworld or the special sciences, both of which are of course richly populated with individual objects? This is just one of the questions explored in our interview.

As physics uncovers more and more of a reality which simply does not work according to the models of our intuitive picture of the world, cognitive neuroscience increasingly reveals the extent to which these models themselves depend more upon the nature of our cognitive processing systems than on the world which they purport to represent. In an interview with **Thomas Metzinger**, we discuss the radical thesis presented in his magnum opus *Being No One* that 'no such things as selves exist in the world: Nobody ever *was* or *had* a self'.[49] Metzinger discusses the bases for and the ramifications of his position, and responds to

49. Thomas Metzinger, *Being No One: The Self-Model Theory of Subjectivity* (Cambridge, Mass.: the MIT Press), 1. See also J. Trafford, 'The Shadow of a Puppet Dance', in **Collapse** IV (Falmouth: Urbanomic, 2008), 185-206.

criticisms of his radical eliminativist position with regard to the existence of selves. Like Ladyman, Metzinger too takes philosophers to task for prioritising 'armchair intuitions' about the nature of the mind over scientific discoveries, but also reflects upon the evolutionary provenance of such intuitions; that is, how 'certain forms of self-deception were adaptive and became superbly robust, spilling over into the enterprise of philosophy and science itself'. But if the 'Copernicanism' of neuroscience consists in its subtracting the real substrate of our 'selves' from all intuitive 'visibility', rendering it incongruent with our biologically-inherited patterns of thinking and rebarbative to efforts to 'make sense' of the world and our fellow humans, is there any way for our *cultural* fabric to 'digest' its deliverances? Here, Metzinger proves more than ready to address the potential social and cultural ramifications of his position: Against the frightening possibilities many find in the prospect of an accomplished science of the mind, he argues that, although it will inevitably entail a profound transformation in our self-understanding, advances such as his self-model theory present potential opportunities for ushering in a new age where society and politics can be informed by scientific discovery: 'Enlightenment 2.0'.

This question of the 'toxicity' of Copernican thought makes explicit the connection between this volume's theme and that of its predecessor, with its suggestion that between the adventures of reason and the comfort of intuition may lurk 'concept horrors' best explored in the imaginings of writers and artists.[50] Painter **Nigel Cooke**'s

50. See **Collapse** IV. Readers who enjoyed the perspective suggested by this volume may be interested to hear of R. Scott Bakker's *Neuropath* (London: Orion, 2008),

contribution gives us a glimpse of the territory in-between the two volumes. Over the last decade, Cooke's massive canvases have introduced their viewers to an 'interzone' of representation, where painting enters into a dialogue with its past that eschews the progressive dialectic of artistic modernism. With formal ingenuity and wit Cooke has invented a mode of landscape painting that depicts the landscape of representation itself, a plane of uneasy coexistence (cartoon vegetables suck disconsolately on cigarettes alongside severed heads smiling up from the undergrowth, before vast walls which serve as a support for weeping graffiti brains ...) whose effect is to disturb and parody received notions of the relative sophistication, meaning and value of images. The contemporary painter, suggests Cooke, faces an objectively 'moronic and hysterical'[51] situation which can be transmuted into opportunity only through a concerted complicity with its groundless condition. Accordingly, Cooke's latest works, exhibited as 'New Accursed Art Club', found the character of 'The Painter' himself absorbed into the canvas, as a vagrant stumbling through the remains of representation, a derelict motif encompassed in his own disorienting predicament. The new paintings Cooke has made for this volume of **Collapse**, entitled 'Thinker Dejecta', are haunted by a close relative of this shambolic figure – The Thinker, overburdened and undermined by what Julian Barbour describes as 'a journey into the totally unknown, in which shock

a 'techno-thriller' inspired by Metzinger's work, which prompted Metzinger himself to warn, in hyperbolic mode: 'You should think twice before reading this – there could be some scientific and philosophical possibilities you don't want to know!'

51. See the absorbing interview with Cooke in S. Malik, D. Leader, N. Cooke, and S. Goetz, *Nigel Cooke: Paintings 01-06* (London: Koenig Books, 2006).

follows shock', slogging on with an intellectual labour that only ever seems to bring him further down in the world. Nonplussed by the puzzling connection between his lofty intellectual flights and the degeneration of his condition, Cooke's thinker drifts in a wasteland, Kant's 'rational delight'[52] a distant memory, while a psychotic sun (recalling Shawcross's experiments in helio-eccentrism) beats down mercilessly on his fevered brow. As in Cooke's other work, the density of reflection compacted into these apparently cartoonish vignettes indexes the entangled motivations, glories and disorienting turns of philosophical thought, that enigmatic mélange of hubris, masochism, and addiction: A compulsion, Cooke suggests, whose crowning insight will be that man was ever its confused instrument rather than its master.

While many philosophers, especially those unacquainted with philosophy of science, assume that naturalism (or 'scientism') entails a radical kind of physicalist reductionism which is constitutively incapable of doing justice to the manifest image of the *Lebenswelt*, as James Ladyman makes clear, and as biologist **Jack Cohen** and mathematician **Ian Stewart** also affirm in our interview 'Alien Science', scientific realism does not necessarily entail impugning the status of everyday macroscopic objects. Cohen and Stewart's collaboration has produced a series of popular science books which are remarkable in their scope, epistemological subtlety and conceptual inventiveness. Much of their work has consisted in a close examination of the development in recent decades of the sciences of chaos and complexity, which seek to systematically account for

52. See Kant, 'On Creation ...', this volume, 399.

the 'emergence' of high-level natural properties on the basis of the abstract microphysical principles described by modern science. It seems that reductionism alone cannot do justice to these macroscopic patterns, which retain a certain autonomy from their component parts, but the precise nature of their 'emergence' remains a vexed question. While Ladyman prefers to avoid the fuzzy term 'emergence' altogether, Cohen and Stewart have sought to develop a theory of emergence that avoids the invocation of any 'magical' properties that would not be fully causally determined by their underlying microphysical properties. Against the accusation that emergentism privileges those features which happen to be phenomenologically available to human beings, they insist that, far from being an anthropomorphic notion, emergentism rather registers our ignorance of the underlying mechanisms. If much of what we perceive is the result of the 'quick and dirty feature-detection systems' of the brain, this is only one of the ways in which nature, of which the human brain/mind is a part, 'collapses' the underlying chaos. Crucially for Cohen and Stewart, it is not only the human brain that perceives nature in terms of high-level structures and features: Just as the scientist singles out specific features of Mars, such as its orbit, position and mass, and models those features mathematically as a curve, a point and a number respectively, so does the sun 'see' Mars as a concentrated mass exerting a gravitational force, rather than as a collection of atoms and force vectors.[53] The human brain is a part of the natural world and the way in which it 'caricatures' the things which

53. Jack Cohen and Ian Stewart, *The Collapse of Chaos: Discovering Simplicity in a Complex World* (London: Penguin Books, 1994), 430.

it comes into contact with is not unique to it. This recalls a position familiar to readers of **Collapse**, as Graham Harman has developed in previous volumes the argument that with an understanding of this 'caricaturing' one can prosecute realism in the macroscopic domain.[54] However, while Harman continues to reserve a special place for an a priori metaphysics which would treat of 'the same world as that of the various sciences but in a different manner',[55] and holds the categories of the manifest world to retain an ontological primacy over the discoveries of science, the work of Ladyman and Cohen and Stewart alike seems to suggest a metaphysics developed entirely on the basis of the deliverances of the sciences, without need for any such metaphysical 'overlay'.

As well as recounting the origins and significance of the key conceptual innovations of their co-authored works ('complicity', 'Ant Country', 'privilege', 'extelligence', etc.), and discussing the relationship of their work to philosophy, in our interview Cohen and Stewart also explain their criticisms of what they see as the overly conservative and unimaginative nature of much of contemporary astrobiology and cosmology. If, according to Rovelli, the strength of science 'resides not in any putative certainties uncovered, but rather *in a radical awareness of our ignorance*', one of the ways which contemporary cosmology has attempted to take into account the intrinsic limitations of the human perspective has been in terms of what is known as 'anthropic

54. See Harman's 'Vicarious Causality', in R. Mackay (ed.), **Collapse** II (Oxford: Urbanomic, 2007), 171-205 ', and 'On the Horror of Phenomenology: Lovecraft and Husserl', in **Collapse** IV, op. cit., 333-64.

55. 'Vicarious Causality', op. cit., 174.

reasoning', which aims to rigorously take into account the fact that our evidence about the universe is restricted by the conditions which must be in place for us to be there to observe it in the first place. As Barrow and Tipler have pointed out, the Copernican revolution itself was initiated by the application of what is known as the 'weak anthropic principle': Copernicus rendered redundant the hypothesis of epicycles by explaining that the retrograde motion of the planets was due to the 'anthropic selection effect' consequent upon the fact that we were observing the planetary motion from the vantage point of the moving earth.[56] Subsequent to Brandon Carter's invention of the term 'anthropic principle' in the early seventies, an increasing number of scientists have turned to anthropic reasoning in order to account for the extreme unlikelihood of the advent of life and intelligence which seems to follow from the 'fine-tuned' nature of the fundamental physical constants of our universe. However, Cohen and Stewart have long been critical of the very idea that our universe is in any way 'fine-tuned', and in our interview they explain their charge that the very notion rests on little more than 'bad logic'.

While Cohen and Stewart are vitriolically dismissive of the very idea of the putative 'fine-tuning' of our universe, astrophysicist **Milan Ćirković** remains unconvinced by their criticisms, which he regards as being largely based upon the outdated idea that anthropic reasoning is necessarily teleological and anthropocentric. In his 'Sailing the Archipelago', Ćirković sketches the philosophical foundations for an epistemologically and

56. Barrow and Tipler, *The Cosmological Anthropic Principle* (Oxford: Oxford University Press, 1986), 3-4.

scientifically sophisticated approach to anthropic reasoning and fine-tuning which, while acutely aware of the kinds of problems emphasized by Cohen and Stewart, does not lead to the conclusion that anthropic reasoning is forlorn. Against the accusation that anthropic reasoning necessarily entails an anti-Copernican privileging of *Homo sapiens*, or of terrestrial, carbon-based life as the only possible kind, Ćirković begins his inquiries by taking seriously the idea that our own universe is only one region of a possibly infinite multiverse, thus 'dealing with the widest conceivable ensemble in which our universe can be embedded, in order to avoid assigning it any special status'. If during the history of science since the Copernican revolution we have witnessed the loss of special status for ever-wider and more encompassing environments, Ćirković suggests that now, in the twenty-first century, 'we should not be surprised to learn that there is nothing special about the whole of our cosmological domain – our universe – either'.

Comparing contemporary cosmologists, astrophysicists and astrobiologists to the great explorers of the European Age of Exploration, Ćirković argues that the fact that earlier voyages had come to the premature conclusion that our island is the only habitable one in no way suggests that the voyage itself is misbegotten: If they were wrong, it was not because of 'some ulterior and heinous agenda [...] [I]t was perfectly reasonable for them to think so – we might compare their rationality to that of a hypothetical ancient philosopher of Easter Island, pondering the huge ocean surrounding his home'. If we think of the range of possible parameters governing the laws of physics as describing a landscape of 'possible universes', then, Ćirković suggests,

we have so far only charted the very small 'island' that is 'habitable' for us. However, this does not mean that we live on the *only* island in this space, or that the type of life for which our universe appears to be 'fine-tuned' is the only type of life possible. If a little humility is appropriate, argues Ćirković, given that we are only beginning to chart this vast topography, it would be absolutely premature to conclude that we are its only possible inhabitants.

While the detractors continue to accuse anthropic reasoning of anti-Copernicanism, Ćirković finds in their criticisms the relics of a Cartesian dualism which fails to take into account the fact that human bodies are 'measuring instruments whose self-selection properties *must* be taken into account, just as astronomers *must* take into account the self-selection properties of optical telescopes'.[57] After all, if the human animal is fully a part of the natural world which science investigates, having evolved through various physical, chemical and biological processes, how can one justify ignoring their properties, or failing to take into account the very special nature of the conditions which had to be in place for those properties to evolve in the first place? Is all science which takes account of the nature of human beings *eo ipso* 'subjective' or 'anthropocentric', or might it not rather be the case that science *needs* to mention human

57. 'Such telescopes tell us about the radiation in the visible band of the electromagnetic spectrum, but it would be completely illegitimate to conclude from purely optical observations that all of the electromagnetic energy in the Universe is in the visible band. Only when one is aware of the self-selection of optical telescopes is it possible to consider the possibility that non-visible radiation exists. Similarly, it is essential to be aware of the self-selection which results from us being *Homo sapiens* when trying to draw conclusions about the nature of the Universe.' (Barrow and Tipler, *The Anthropic Cosmological Principle*, op. cit., 3-4).

beings in order to *be* objective?[58] Thus, far from being a prop to human self-importance, a 'reactivation [of] finalist thought', or a reversion to the doctrine of Copernicus' own teleological anthropology (as Quentin Meillassoux argued in an earlier volume of **Collapse**),[59] Ćirković's work demonstrates how anthropic thinking merely stems from a deepening of the 'Copernican imperative' which imposes itself once physics begins to consider landscapes of physical possibility beyond the actual universe. Thus, contrary to the critics' charges, the anthropic programme of the investigation of observation selection effects, far from amounting to a 'betrayal of the Enlightenment', is rather 'the continuation of the Copernican revolutionary spirit in overcoming not only the apparent specialness of the Earth and of life on it, including humans, but of the very special laws, associated mathematical structures, and our universe in general'. While it may take generations of astrobiologists before quantitative precision is reached, Ćirković argues that the enormity of the task 'should not detract from the fact that the problem is a well-defined one from the start'.

Whereas Cohen and Stewart enthuse about the possibility of the discovery of alien life – '[f]inding aliens (even bacteria) would be fantastic [; c]omplex aliens, at the level of a snail, would be amazing [; t]he level of intelligence of a cat – awe-inspiring' – transhumanist philosopher

58. This is a point forcefully made by Sherrilyn Roush in her excellent 'Copernicus, Kant, and the anthropic cosmological principles' in *Studies in the History and Philosophy of Modern Physics* 34 (2003), 5-35. This paper also sheds further helpful light on many of the connections between Copernicanism, Kantianism, and anthropic reasoning explored in this volume.

59. Q. Meillassoux 'Potentiality and Virtuality', in R. Mackay (ed.) **Collapse II** (Oxford: Urbanomic, 2007), 55-81, 78.

Nick Bostrom argues in 'Where Are They?' that such findings, far from being a cause for celebration, would in fact augur very badly for the future of the human race. Bostrom's work as an analyst of 'existential risk' here dovetails with his work on anthropic thinking, as he unravels the consequences that would follow from such a discovery. Were traces of life discovered elsewhere in our solar system – on Mars, say, or upon Jupiter's moon Europa – most people would of course be thrilled, perhaps even comforted to learn that we are not entirely alone in the cosmos. However, for Bostrom, no such news could be good news, and indeed the more complex life we found, the more depressing that news would be. On the basis of two well-known facts – namely, that our galaxy alone harbours billions of potential germination points for life, and yet that decades-worth of searching for traces of extraterrestrial life has consistently failed to detect any signs of intelligent life – Bostrom argues that there must exist a 'Great Filter' that renders the existence of advanced technological civilisations exceptionally improbable. The crucial question then becomes where this Great Filter might be located. If it is located in our evolutionary past, this would be good news, since it would suggest that the great fluke which ushered us into existence had already taken place. However, should we ever find evidence of life on other planets, and especially were we to find it to have independently evolved somewhere in our own solar neighbourhood, this would of course suggest that life is commonplace, meaning that the Great Filter still awaits us: a prospect that would leave our future chances of survival looking very bleak indeed.

Speaking about his early exposure to physics and mathematics, artist **Keith Tyson** has said: 'once I could see myself as part of a network everything became clearer'.[60] But in using the structures of scientific experience to 'explore the myth of individuality', he adamantly maintains his right to creatively transform them. His work thus marries a keen attentiveness to the concepts of contemporary science with a tendency to appropriate them into conceptual 'machines' to steer his artistic practice, as in projects such as *Geno/Pheno* (2005).[61] Refusing to grant scientific conceptualisation any overarching role in his work, he instead sites it within a broader, transversal network of ideas whose dazzling multiplicity is reflected in works such as 2006's *Large Field Array*. This work – whose title adverts to the Very Large Array on the plains of San Agustin, New Mexico, where twenty-seven massive radio telescopes combine their multiple viewpoints to produce high-resolution astrophysical imaging – consists of a 'rhizome' or 'huge soup' of elements arrayed in a vast grid according to lines of affinity traced by Tyson himself, and reflecting his own multiple interests, memories and experiences. Thus Tyson extends the cosmological ambition to address 'everything' to extra-physical forces: 'We are the things that are carrying those forces. Including history. Including energy. All sorts of fields. So everything is the sum of all possible paths. And that's what [*Large Field Array*] is about. All those intricate interrelations.'

The conceit of Tyson's contribution to **Collapse** lies in making a short series of images stand for a similarly

60. K. Tyson *Studio Wall Drawings 1997-2007* (London: Haunch of Venison, 2007), 2.

61. See K. Tyson *Geno/Pheno* (NY: Pace Wildenstein, 2005).

megalomaniacal ambition – that of employing the entire history of the universe as a pool of 'time-based media'. The work draws upon the Einsteinian model of four-dimensional spacetime, or 'blocktime' – Tyson explains: 'If we accept blocktime as a working model in which any position in time, space and possibility is a frame within a 3D animation, we could splice together single frames in the celestial cutting room as a kind of random sampler'. Ironically, the presentation of such an 'animation' as a series of stills on the page is all the more apt given Julian Barbour's thesis of the 'unreality of time', entailing as it does a modification of Einsteinian blocktime whereby Tyson's 'animation' would cease to be animated at all. Meanwhile, the inclusion in the images delivered by his 'random splicing' of disproportionately many images of our planet is perhaps as unlikely ('uncopernican') as it is comforting: but, as Tyson – an erstwhile gambler – has said, he doesn't believe in chance, or at least only as a name for a human constraint which is there to be explored. Here again, the universal reach of science is twinned with a sanguine acceptance of the artist's own unique location in time, space and history.[62]

Of course, for many philosophers the notion of 'Copernicanism' as entailing a subtraction of scientific knowledge from the conditions of intuition will seem utterly alien. For 'Copernicanism' in philosophy has become a byword for what is in effect understood, in Kant, to be a recentring of the universe precisely around the power of cognitive synthesis harboured by the knowing subject. By making phenomenal reality orbit around a transcendental subject

62. 'The Wu Way', interview with Dominic van den Boogard, available online at http://www.keithtyson.com/#/projects/largefieldarray/writings/.

which is supposedly distinct from and yet indissociable from the human subject, Kant is deemed to have inaugurated what Quentin Meillassoux has recently denounced as a 'Ptolemaic counter-revolution' that re-installed human experience at the centre from which Copernicanism had displaced it.[63] However, in his 'The Phoenix of Nature: Kant and the Big Bounce', **Martin Schönfeld** presents us with a vivid picture of Kant profoundly at odds with this recent popular characterisation of him as a conservative, anti-Copernican thinker, by way of an examination of his 1755 work *Universal History of Nature and Theory of the Skies*.[64] Here we encounter a radically anti-anthropocentric, anti-Christian, naturalistic, and speculatively audacious Kant who pushes 'Copernicanism' to its limits, abolishing the hand of God from the Newtonian cosmos and introducing history and evolution into it. This is Kant as the Copernican revolutionary who as early as 1755 strongly anticipates the fundaments of what became the Standard Model of modern cosmology only in the 1920s. More specifically, Schönfeld introduces the reader to an undeservedly neglected idea from Kant's early cosmology ('the Phoenix of Nature'), one which takes on surprising significance in view of the very latest hypotheses and findings of contemporary (quantum loop) cosmology: 'the Big Bounce'.

63. See Quentin Meillassoux, *After Finitude: An Essay on the Necessity of Contingency*, Tr. R. Brassier (London and New York: Continuum 2008), Chapter Five.

64. It is strongly recommended that this essay be read in connection with Schönfeld's more in-depth treatment of Kant's 1755 work and its context in his superb 'Kant's Early Cosmology' in G. Bird (ed.), *A Companion to Kant* (Oxford: Blackwell, 2006), 47-62. See also Schönfeld's *The Philosophy of the Young Kant* (Oxford: Oxford University Press, 2000), and his entry for the *Stanford Encyclopedia of Philosophy*, 'Kant's Philosophical Development', online at http://plato.stanford.edu/entries/kant-development/

To accompany his piece, Schönfeld also provides a new translation of the chapter from the *Universal History of Nature* in which the Phoenix of Nature appears: 'On Creation in the Total Extent of its Infinity in Space and Time'. This work will certainly come as a surprise to those familiar only with Kant's critical works, or with a contemporary *doxa* aligning Kant unproblematically with an idealism that is constitutively incapable of breaking out of the 'correlational circle' in order to take the measure of the 'Great Outside'.[65] Its astonishingly prescient cosmology of 'island universes' and the birth and death of 'worlds' presents a truly awe-inspiring vision of the cosmos, thought-provoking even to those familiar with the latest developments in astrophysics. Popper called the *Universal History of Nature* 'one of the greatest contributions ever made to cosmology and cosmogony',[66] and as Schönfeld notes, Kant's daring conjectures have been to a significant extent vindicated in their general outlines by modern cosmology.

Embarking as it does upon what Kant, with tangible enthusiasm, calls 'the greatest and most awesome subject imaginable',[67] the *Universal History of Nature* sketches what Blumenberg calls 'a monumental panorama of the endless evolution of worlds, still from the point of view of a faculty of reason that, so to speak, adopts the standpoint of divinity and identifies itself with the divine view of the world'.[68]

65. Again, see Meillassoux, *After Finitude*, op. cit.

66. Popper, *Conjectures and Refutations*, op. cit., 240.

67. From the Preface of *Universal Natural History and Theory of Heaven*, trans. Ian Johnston, available online at http://records.viu.ca/~johnstoi/kant/kant2e.htm.

68. Hans Blumenberg, *The Legitimacy of the Modern Age* (Cambridge, Mass.: MIT Press, 1985), 212. The following passage contains several close paraphrases of Blumenberg's text; sources are indicated in the footnotes.

Here man appears, 'among the immense vortices of the self-propagating worlds, as but an ephemeral episode. This whole infinite extravagance of a "world of worlds", of galaxies and supergalaxies, is conceived in relation to omnipotence, as the latter's demonstration of itself to itself'.[69] Though still partially in thrall to the teleological metaphysics of the 'great chain of being', and speaking of 'degrees of perfection', it is clear that Kant sees no connection between man's history and this process of improvement. Whereas Romantic thinkers such as Friedrich Schlegel took the unfinished nature of the world to indicate that man's vocation was to play a role in completing it, for Kant there is no such anthropocentric teleology in play. That the world is ever 'unfinished' has nothing to do with human action but is due to its having been created by an inexhaustible power, which Kant speaks of, in Spinozistic fashion, as either 'God' or 'Nature'. Man, 'who seems to be the masterpiece of creation', finds his place with the 'world of worlds' precisely where there is an already 'perfected world structure', among others still in the process of coming into being or disintegrating.[70] In a startling anticipation of Ćirković's position, Kant holds that the universe is not made for man, but that the infinite process of the evolution of worlds creates temporary 'habitable zones'. Habitability is not a lasting and ubiquitous feature of the bodies of the universe, but is only the result of the fact that the total reality, in analogy to the distribution of habitability on the earth, also has its 'temperate zones'.[71]

69. Ibid.

70. Ibid., 212-3.

71. Blumenberg, *The Genesis of the Copernican World*, op. cit., 591.

As Kant explains in one of his letters, it was the cosmological problem of the finitude or infinitude of the universe that led him to his theory of knowledge in the first *Critique*,[72] and as Schönfeld suggests, one should not underestimate the degree of continuity between this early work and the later critical philosophy. This is borne out by a comparison of the two passages below, the first from the *Universal History of Nature*, the second from the *Critique of Pure Reason*:

> If the size of a planetary system in which the Earth is hardly seen as a grain of sand fills the understanding with astonishment, how delightfully astounded we will be when we examine the infinite crowd of worlds and systems which fill the totality of the Milky Way. But how much greater this wonder when we know that all these immeasurable arrangements of stars once again create a numbered unity, whose end we do not know and which is perhaps, like the previous one, inconceivably large and yet, once again, only a unit in a new numbered system. We see the first links of a progressive relationship of worlds and systems, and the first part of this unending progression already allows us to recognize what we are to assume about the totality. Here there is no end, but an abyss of a true infinity, in which all capacity of human thought sinks, even when it is uplifted with the help of mathematics.[73]

> The observations and calculations of astronomers have taught us much that is wonderful; but the most important lesson that they have taught is has been by revealing the abyss of our ignorance, which otherwise would never have been conceived to be so great. Reflection on the ignorance thus disclosed must

72. As noted by Popper, *Conjectures and Refutations*, op. cit., 240-1.

73. *Universal Natural History and Theory of Heaven*, op. cit., Part One, 'On the Systematic Arrangement of the Fixed Stars'.

> produce a great change in our estimate in the purposes for which our reason should be employed.[74]

If Rovelli suggests that the problem is that we 'use concepts that we have developed in our very special environment (characterized by low velocities, low energy ...) and we think the world as if it was all like that',[75] this is also a sentiment shared by Kant, who puts the order and structure we see down to 'anthropic' considerations regarding our spatial and temporal location in the universe. Whereas 'from our perspective in the Universe, it would seem as if we looked at wholly completed creation and, so to speak, at an infinite array of systematically connected world-orders [...] if we could step outside this evolved sphere, we would see chaos' and a 'random scattering of elements'.[76] Similarly, in Part Three of *Universal History of Nature*, itself devoted to speculations regarding the inhabitants of other planets, Kant compares the worldview of human beings with that of a louse inhabiting the head of a vagrant:

> Let us judge in an unprejudiced manner. This insect, which in its way of living as well as in its lack of worth expresses very well the condition of most human beings, can be used for such a comparison with good results. Since, according to the louse's imagination, nature is endlessly well suited to its existence, it considers irrelevant all the rest of creation which does not have a precise goal related to its species as the central point of nature's purposes. The human being, who similarly stands

74. *Critique of Pure Reason*, op. cit., A575/B603.

75. *Edge: World Question Center*, Annual Question 2006: 'What is Your Dangerous Idea?', op. cit.

76. See Kant, 'On Creation ...', this volume, 396.

infinitely far from the highest stages of being, is sufficiently bold to flatter himself with the same imaginative picture of his existence as essential.[77]

It should be borne in mind that Kant never completely abandoned even some of the most speculative views expressed in the *Universal History of Nature*. Thus, in the celebrated conclusion of the *Critique of Practical Reason* he speaks of 'an unbounded magnitude with worlds upon worlds and systems of systems',[78] and in the *Critique of the Power of Judgement* likewise of 'the Milky Way, and the immeasurable multitude of such Milky Way systems, called nebulae'.[79] Indeed, as **Iain Hamilton Grant** points out in his 'Prospects for Post-Copernican Dogmatism', it would be a matter of considerable irony if a *soi-disant* 'Copernican' revolution in philosophy should have put an end to the project of a *Universal History of Nature*. However, there is of course no doubt that the critical philosophy brought about a hugely significant transformation in Kant's epistemological approach, and in this regard Grant suggests that the 'dogmatism' against which Kant contrasts his critical conception of philosophy is none other than the naturalism of his own 'pre-critical' writings. This raises a number of important questions regarding the relationship between transcendental philosophy and a naturalistic ontology, questions which are skilfully examined in Grant's paper.

77. *Universal Natural History and Theory of Heaven*, op. cit., Part Three, 'An Attempt, Based On Natural Analogies, at a Comparison Between the Inhabitants of Different Planets'.

78. *Critique of Practical Reason* (Cambridge: Cambridge University Press, 1997), 133 [*Ak*: 162].

79. *Critique of the Power of Judgement* (Cambridge: Cambridge University Press, 2000), 140 [*Ak*: 256].

Exploring the paradoxes and antinomies that result from the attempted combination of transcendental philosophy and a physics-based ontology as it arises in Kant and post-Kantianism, Grant finds transcendental philosophy, as defended by both Kant and Fichte, to be itself 'dogmatic' according to its very own criteria. Taking into account Kant's late revisions of his critical philosophy in the light of advances in the natural sciences, Grant argues that transcendentalism's susceptibility to naturalistically driven ontological change inevitably pushes a rationally consistent transcendental philosophy in the direction of Schelling's 'transcendental naturalism'.

In 'A Throw of the Quantum Dice Will Never Overturn the Copernican Revolution', **Gabriel Catren** also draws upon Schelling's *Naturphilosophie* in proposing what he calls a 'speculative overcoming' of recent quasi-Kantian interpretations of quantum mechanics. Rather than being limited to a mathematical account of the correlations between 'observed' systems and their 'observers', or pointing to the inherent 'transcendental limits' of physical knowledge, Catren argues that quantum mechanics furnishes a complete and realistic description of the intrinsic properties of physical systems, an ontology which exemplifies the Copernican deanthropomorphisation of nature. While Catren is sympathetic to Quentin Meillassoux's suggestion that Kant's Copernican revolution ultimately eventuated in a kind of 'Ptolemaic Counter-Revolution', and argues for an explicitly 'pre-critical' approach to the interpretation of quantum mechanics, he is also severely critical of Meillassoux's a priori arguments regarding 'necessary contingency'. Indeed, Catren finds Meillassoux guilty of

recapitulating a paradigmatic gesture of 'Kantian' critique: that is, of presuming to stipulate, in purely philosophical terms, what physicists will never be able to do. Through an ingenious appropriation of resources from the history of philosophy and the models of mathematical physics, Catren succeeds in providing an interpretation of quantum mechanics that seems able to satisfy the often mutually-exclusive requirements of philosophical intelligibility *and* mathematical coherence. While Catren's interpretation is doubtless controversial in its suggestion that it enables us to recover the 'classical' notions of 'decontextualised objects' and 'intrinsic properties' from within quantum mechanics – a thesis which would seem to run directly counter to the kind of interpretation developed by the likes of Ladyman – there is no doubt that Catren's essay presents a challenging thesis, and outlines a project for a 'speculative physics' that deserves to be followed closely.

If in Cooke's errant figure of the dejected cognitive labourer wandering a scorched earth we see the human thinker bent under the epochal 'humiliations' dealt by Copernicus, Darwin and Freud, **Alberto Gualandi** discovers a certain 'errancy of the human' to be the very source of its cognitive prowess. In contrast to Grant and Catren's bold proposals for a Schelling-inspired 'speculative physics' which would push the Copernican deanthropomorphisation of nature to its limits, Gualandi argues for the need to establish a new 'circular and communicative' theoretical interface between science and philosophy which would be capable of both integrating the natural and the human sciences and overcoming the antinomy between Kant's 'Copernican revolution' and that of Copernicus

himself. Exploring the features common to certain speculative philosophies of nature in 1960s France and problems facing current evolutionary biologists, Gualandi introduces a 'neotenic conception of the human animal' capable of taking into account what he calls 'the necessary complementarity between the *critical* and *eccentric* dimension of man'. While it would be impossible to do justice to this superbly rich and thought-provoking paper here, we would note that it brings into focus the many reasons why the notion of 'Copernicanism' is still important for philosophy and for the sciences today, and will certainly repay careful and repeated reading.

Whereas Gualandi insists on the human and embodied nature of all knowledge, and adverts to the unsurpassability of Kant's Copernican revolution, **Paul Humphreys** proposes that computational science is fast displacing humans from the centre of the epistemological universe, a revolution which will eventually produce as radical a transformation in our self-image as did the Copernican revolution itself. Beyond the implicitly anthropocentric epistemologies of an empiricism which would limit the knowable to what is accessible to a set of biologically-contingent devices and a realism whose criterion of reality invokes independence from human minds, Humphreys considers the possibility of a purely automated science for which the division between what is and what is not accessible to the human mind would be, ironically, an entirely 'artificial' one. While Kant rejected the idea of obtaining knowledge of the world as it is in itself on the grounds that it would require us to have 'a faculty of knowledge altogether different from the human [...] in other words, that we should be not men

but beings of whom we are unable to say whether they are even possible, much less how they are constituted',[80] Humphreys' paper suggests that such beings may already be among us. If we have not yet entirely relinquished the hope of one day being able to 'finally penetrate the barriers that have stood between between us and the rest of reality', Humphreys argues that the sooner we understand how 'some instruments and some computers confront reality non-conceptually' the better. Might not this also prove to be a necessary part of the task of what Metzinger calls 'Enlightenment 2.0'? In this regard, it seems appropriate to close this introduction with a citation from the conclusion to Kant's *Universal History of Nature*: 'We do not really know what the human being truly is today. [...] How much less would we be able to guess what a human being is to become in the future!'

We would like to conclude by offering our most sincere gratitude to all of our contributors and collaborators, whose wholehearted commitment to this project has consistently been above and beyond the call of duty. We hope that the fragments of the 'big picture' assembled in this unique volume will compensate them for their efforts.

Damian Veal,

Mexico City, January 2009.

80. *Critique of Pure Reason*, op. cit., A277-8/B333-34.