

Thermodynamics and theology

Turn-of-the-century cosmologies, 1850-1920

Helge S. Kragh, *Entropic Creation: Religious Contexts of Thermodynamics and Cosmology* (London and New York, Routledge, 2016), 272 pp. (First published in 2008 by Ashgate)

Since about 1860 the two laws of thermodynamics, variously formulated, have been taken to be laws of nature, assumed to be the most general statements possible about the universe as a whole. Although Albert Einstein denied final theories of physics, he excluded thermodynamics from this because of its simplicity and high degree of generality. He argued, carefully, as you will see, that it 'is the only physical theory of a universal content which I am convinced that within the framework of the applicability of its basic concept, will never be overthrown' (34).

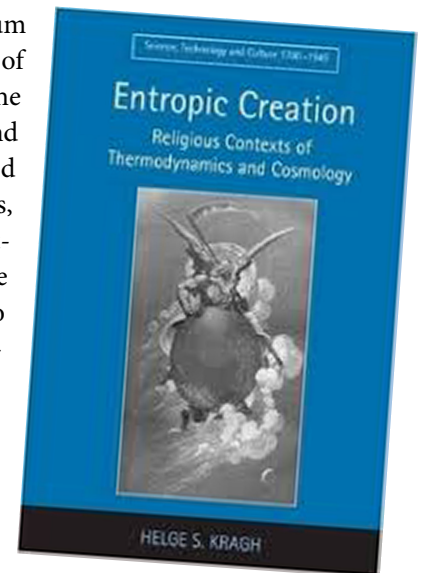
The first law of thermodynamics declares that the total energy of a closed system remains unchanged, or energy cannot be created or destroyed, even if it can change form. The second – well, the second is not so easy to express or to interpret. A late formulation of it may be relatively familiar to students of physics: the entropy of the universe tends towards a maximum. This conveys the idea that every energy transfer that takes place will reduce not the amount of energy but the amount of usable energy, converting useful energy that can do work to heat. This is described in energy terms as increasing dissipation, or entropy, and entropy is the key concept under investigation in this book.

The second law has several implications, fascinating to both natural philosophers and theologians in the seventy-year period under discussion, not least in relation to the 'arrow of time'. The second law tells us that there is irreversibility in transitory processes; we

cannot go back to minimum entropy. One implication of this, firmly present in the popular imagination and more widely disseminated than the laws themselves, is that this will lead inevitably and inexorably in the dim and distant future to a 'thermal end' of the universe, a heat death – or cold death, no absolute temperature is implied – when all energy has been converted to useless heat.

If you turn back the arrow of time under these conditions of knowledge, then the proposed corollary of the heat-death hypothesis must be that the universe had a beginning in time, assuming that the second law is valid for the universe as a whole and observing that we do not currently live in a high-entropy world. It does appear that here, in the late nineteenth century, empirical science steps in to settle the age-old debates about the finitude of the universe. It is not widely recognized that the second law was then at the centre of heated debates and later even considered a *theoria non grata* by some materialist and socialist thinkers. This book sets out to document those debates in the history of natural philosophy and theology, though interestingly, Kragh observes, they do not belong yet to the history of astronomy.

Differences of opinion about the finitude of the universe are not new and the book traces earlier arguments about decay and creation. Lucretius's



denial of creation by asserting the permanence of matter – nothing comes from nothing – follows from Aristotle's notion that the universe must be finite in extent but infinite in duration. The Stoic Zeno objected to this thesis on the grounds that physical processes – for example erosion – are clearly unidirectional, a theme that recurs in later models. That the universe should be thought of as finite is also argued by a Christian sixth-century Neo-Platonist, John Philoponus, who was also known to and an inspiration for Islamic theologians on this point. He argued against the absurdity of 'pagan infinitism' on the basis of the asymmetry between past and present (the arrow of time).

The idea of irreversible and dissipative processes in nature also appeared in geology and geophysics. From Copernicus to Newton nature was understood to be slowly but irrevocably dying, although Newton was not concerned with the evidence from the erosion of the surface of the planet but with the decay engendered by 'celestial gravitational perturbations' (17).

Theologically this picture was inaugurated by Reformation shifts that connected the moral fall of humanity with the cosmic fall of the earth and the cosmos. It was also a reiteration of a long-standing argument against 'pagan' notions of a changeless or cyclical eternity.

Kragh describes, without over-interpreting, these theological and biblical debates, noting for example that the bible, as an authority, is not univocal on beginnings and ends. Whatever the *eschaton* might bring in the far distant future, it was not annihilation so much as a transformation. And the teleological turn in theological thinking, the faith in a beneficent creative power, was mirrored in the claims made for the new science by natural philosophers that put their faith in the narrative of knowledge and progress. This is an instructive and enjoyable chapter.

Kragh then introduces a condensed history of thermodynamics, which is at times obfuscating. It might be that this is due in part to the nature of the subject matter itself, but also because he is over-concerned to begin his account in the midst of this history rather than through a lens of his own making. This is followed by a chapter on contemporaneous concepts of the universe: as finite or infinite; closed or open, and fitting into either a cyclical or steady-state world picture, or an evolutionary or creationist one.

These chapters are not easy to navigate or to digest, and although a historian's task is to docu-

ment the evidence in all its vagaries, this was heavy going, requiring the reader to trawl through lists of protagonists and nuanced readings of readings. The book's subsequent Summary and Overview came as a welcome relief on page 213, and each of the chapters would have benefited from such a treatment: a more comprehensive introduction, and a closing explication. The table of contents is minimal and despite an adequate index the electronic form of the book will, I suspect, be a necessary companion for researchers who seek to plumb its depths. Nevertheless, this can be a fascinating read.

In chapter four his careful distinctions between restricted forms of the arguments for entropic creation (proof of a finite age of the universe) and wide forms (proof of God's creation of the world) are revealing of denominational concerns. Attempts to turn the argument into a scientifically-based proof of God's existence, for example, were discussed more often among Catholics in the German-speaking world, and also in Great Britain. Kragh however is aware that theologians saw the dangers of using science apologetically, that creation theology is more complex than this would imply, and that none of these arguments were used to bolster a full-blown proof of creation out of nothing. Deploying entropy in the service of faith was also rooted in a more ancient assumption: that the books of nature and of scripture cannot contradict each other, but neither are they reducible to each other. Catholic theologians were also at times just as content to rely on Aquinas, who made a clear distinction between faith and demonstration: that the world began to exist is an object of faith, but not of demonstration or science (82). Either way, the theological recourse to the second law was largely abandoned by WWI, although as a 'shadow from the past' it continues to re-emerge in its more strident form in some creationist literature.

In the last chapter, Kragh tells us that in the post-1920s era, entropy and its implications seemed to some minds to be opposed to revolution. One Stalinist ideologue argued that its supporters were 'falsifiers of science'. The rival concept of the infinite material universe was enshrined in official Soviet cosmology, as it was seen to cohere with the dialectical materialism of Lenin. And even as Soviet science was gradually depoliticized, cosmology was still viewed in China as a betrayal of proletarian science up until late in the twentieth century.

With the advent of the current, and also chal-

lenged, consensus on the emergent universe model, a finitely-aged universe could be discussed scientifically without involving the entropy law. Theologians, I suggest, were happy to enjoy a humble consonance. And new, naturalised eschatologies – such as that of David Deutsch's *The Fabric of Reality* (1997) – have also been born: speculative, scientific scenarios about a far-future virtual eternity, driven by our immortal longings. Plenty for theological anthropology to ponder there.

As for the second law of thermodynamics, it may not be applicable to the universe as a whole and there is no reason to expect a meaningful interpretation of the total entropy of the universe any time soon. All the law says is that entropy increases except when it does not (220). Thus proving that Einstein was a careful scientist.

This is not an easy read, and the author gives the reader only a small number of signposts to negotiate the extensive and detailed accounts of this period in the history of science. However, it is a significant and meticulous piece of work, that self-consciously distinguishes between scientific claims, ideology, metaphysics, religious presuppositions and sheer wishful thinking (220). In very many places it is well worth the effort. ■

CATHRIONA RUSSELL

Dr Cathriona Russell is Dungannon and Beresford Professor in Theology at the Department of Religions and Theology, Trinity College, the University of Dublin.