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Affirming Entropy

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Abstract

This paper challenges the frequent demonisation of entropy in philosophies of technology which attempt to draw a "naturalised" axiology from thermodynamics, information theory, and related sciences. Such philosophies include Wiener's cybernetics, Stiegler's neganthropology, and Floridi's information ethics, in each of which entropy designates the *evil* which must be fought in the name of life, information, or some other notion of "the good." The perspective the paper develops to argue the case is Nietzschean. Nietzsche himself rejected the consequences of the Second Law, but I wish to argue that it is possible to *affirm* entropy, for Nietzschean reasons.

First, the paper argues that the reason Nietzsche rejected the Second Law is that it provides consolation for the pessimist (an argument made by von Hartmann). Eternal return should be affirmed because it is the *more difficult* position, and so provides the ultimate existential test. However, metaphysical and existential reasons must give way to the more recent scientific evidence, especially the dating of the universe, which undermines Nietzsche's argument against heat death. While this is alone sufficient reason to affirm entropy, the position is supported by two further classes of reasons. First, the oppositions which have supported the traditional ascription of values to negentropy and entropy can be challenged; and 2) entropy can be seen as consonant with the characteristics of existence which Nietzsche sought to affirm, especially *becoming*.

Keywords

Entropy; Thermodynamics; Philosophy of Technology; Nietzsche; Eternal Return; Value; Life

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Introduction

Contra long-prevailing wisdoms, *entropy should be affirmed.* The aim of this paper is to argue the case. Since William Thomson (Lord Kelvin) drew the consequences of the Second Law of thermodynamics—the tendency of entropy to increase in closed systems—to the cosmic level of the "heat death" of the universe, entropy itself has frequently been cursed as a veritable force of evil. Numerous scientists and philosophers have demonised entropy, using it as an inspiration for naturalising values and construing it as the general antagonistic principle against which everything valued as "good" contends. Entropy has typically been characterised as disorder, disorganisation, dispersal, dissolution, and death. The Second Law has been interpreted to mean the inevitable triumph of entropy over order, organisation, creativity, change, civilisation, progress, life, and so on. In short, entropy has very frequently been understood as the naturalised equivalent of the theological notion of evil, and has been denounced and negated as such. This tendency has been significantly evident in philosophies of technology. In what follows, I will adopt a Nietzschean framework through which to argue that this construal of entropy as evil is deeply problematic and wrongheaded, and that entropy should instead be affirmed.

Section one presents a summary survey of a number of prominent positions that "demonise" entropy, in order to demonstrate that the position I am arguing against is not a mere phantasm, but a real position that has frequently been explicitly adopted in influential scientific and philosophical literature. After charting the appearance of entropy and its negative construal in early thermodynamic theory, I focus on some contemporary philosophers of technology and the pedigree they themselves cite: Bernard Stiegler and Luciano Floridi are taken as prominent representatives, and Norbert Wiener and Erwin Schrödinger as key influences.[1]

1 A recent publication, Drew M. Dalton's *The Matter of Evil: From Speculative Realism to Ethical Pessimism* (Evanston, Ill: Northwestern University Press, 2024), has argued for an understanding of entropy as an objective evil, and situated pessimists such as Arthur Schopenhauer, Philipp Mainländer, and E.M. Cioran as contributing to a tradition which supports this. Such philosophers reason that existence is evil because the inevitability of decay means that the striving of life is fundamentally bound to suffering and death. It would further the general argument mounted against the construal of entropy as evil to engage with this work, but such a task is beyond the scope of this paper. First, because my focus here is on entropy, and while Dalton (as have others) associates the metaphysical principle of decay to be found in these pessimists with entropy, they do not explicitly engage with it themselves. Second, the thinkers I primarily take issue with here are not pessimists, but rather "negentropy optimists": they do not deny the value of existence, but rather establish a fairly conventional "naturalised" ethic of good and evil on the basis of negentropy and entropy. In such a naturalised schema entropy is taken as a force of evil, but only as an oppositional principle which allows the establishment of a positive value of existence in negentropic terms. A technological criterion seems to govern how these thinkers understand the "evil" implications of entropy: it is not suffering that is problematic for them, but rather a final state of the universe in which there is no more energy available to do work, i.e., the machinery of the cosmos will eventually break down in "heat death."

Section two tackles Nietzsche's own treatment of entropy and the Second Law. This is an important step in my argument, because it has become fairly well known in the secondary literature that Nietzsche himself actually rejected the consequences of the Second Law, along with the idea of any final state of the universe. Arguably, however, the reasons *why* he rejected those consequences has not been well understood, and my aim here is to clarify this issue. This will then pave the way for a "Nietzschean" affirmation of entropy, against the letter of his texts but in the spirit of his philosophy.

Section three compares Nietzsche's arguments with more recent relevant scientific data, demonstrating that we have much stronger reason to accept entropy today on scientific grounds than he did in the nineteenth century. Section four critically deconstructs some of the main oppositions which have upheld the moral privileging of negentropy over entropy, and section five argues that entropy is in fact close in many ways to Nietzsche's preferred cosmology, especially in its aspect of becoming. The argument of the paper leads to the conclusion that if we are to affirm *existence* in a Nietzschean fashion in light of our currently available scientific and philosophical understanding, then *entropy* should in fact be affirmed.

1. Entropy Demonised

> The Second Law is all about entropy increasing, which is just a technical way of saying that things get worse.
>
> —Peter Atkins[2]

> *Enter* MEPHISTOPHELES.
>
> —Goethe, *Faust*

1.1 Thomson's "Heat Death"

> [W]e must admire the sagacity of Thomson, who, in the letters of a long-known little mathematical formula, which only speaks of heat, volume, and pressure of bodies, was able to discern consequences which threatened the universe, though certainly after an infinite period of time, with eternal death.
>
> —Hermann von Helmholtz[3]

2 *Order and Disorder*, Episode 1: *Energy*, BBC, 2012.

3 "On the Interaction of Natural Forces," in *Science and Culture: Popular and Philosophical Essays*, ed. David Cahan (Chicago and London: University of Chicago Press, 1995), 30.

Rudolf Clausius introduced the term "entropy" in 1865[4], to describe dispersed or "spread out" energy that is no longer useful for doing work. How did it come to pass that this notion came to be vilified and associated with theological and moral notions of evil? Here we need to point to the closely associated Second Law of thermodynamics. Early formulations by Thomson and Clausius simply describe this law in terms of heat flowing from a higher temperature body to a lower temperature body and never *vice versa*, something of which it is not obvious we ought to be afraid.[5]

The idea that there might be something deeply worrying about entropy was introduced with William Thomson's 1852 lecture "On a Universal Tendency in Nature to the Dissipation of Mechanical Energy."[6] Here he briefly concludes, from the Second Law, that

> 1. There is at present in the material world a universal tendency to the dissipation of mechanical energy.
> 2. Any *restoration* of mechanical energy, without more than an equivalent of dissipation, is impossible […]
> 3. Within a finite period of time past, the earth must have been, and within a finite period of time to come the earth must again be, unfit for the habitation of man as at present constituted […].[7]

Here Thomson draws out the implications of the Second Law already implied by Sadi Carnot's pioneering work in thermodynamics, and states, without further comment, the consequence that the earth must be at some time in the future uninhabitable to human beings in their current form. He did not himself use the term "heat death" (which originated with Ludwig Boltzmann) but was credited with the idea by latter commentators (see the comment by Helmholtz which heads this section).

With reference to Carnot and Thomson, Hermann von Helmholtz then expanded the consequences of the Second Law to encompass the entire universe in his 1854 lecture "On the Interaction of Natural Forces":

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4 Rudolf Clausius, "On Several Convenient Forms of the Fundamental Equations of the Mechanical Theory of Heat," in *The Mechanical Theory of Heat*, ed. T. Archer Hirst (London: John Van Voorst, 1867).

5 Thomson, for example formulated it as follows: "It is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects." "On the Dynamical Theory of Heat, with Numerical Results from Mr. Joule's Equivalent of a Thermal Unit, and M. Regnault's Observations on Steam," [1851] in *Mathematical and Physical Papers 1.* (Cambridge: Cambridge University Press, 2011), 179.

6 Thomson, "On a Universal Tendency in Nature," in *Mathematical and Physical Papers 1* (Cambridge: Cambridge University Press, 2011).

7 Thomson, "On a Universal Tendency in Nature," 514.

> [T]he first portion of the store of force, the unchangeable heat, is augmented by every natural process, while the second portion, mechanical, electrical, and chemical force, must be diminished; so that if the universe be delivered over to the undisturbed action of its physical processes, all force will finally pass into the form of heat, and all heat come into a state of equilibrium. Then all possibility of a further change would be at an end, and the complete cessation of all natural processes must set in. The life of men, animals, and plants could not of course continue […] In short, the universe from that time forward would be condemned to a state of eternal rest.[8]

The idea was again stated, in a way that became more popular and influential, by Clausius in his 1867 lecture *Über den zweiten Hauptsatz der mechanischen Wärmetheorie* [On the Second Principle of the Mechanistic Theory of Heat]. Clausius describes "heat death" in terms of a "limiting state" of maximised entropy, which he presents as an inexorable, if distant, fate:

> Although the current state of the world is still far from reaching this limiting state, and the approach to it happens so slowly that all the time periods we consider as historical times are only short spans compared to the immense durations required for significant transformations in the world, it remains an important outcome that a natural law has been discovered which conclusively suggests that not everything in the world is cyclical, but rather it continually changes its state in a certain sense and tends towards a limiting state.[9]

These scientific presentations of entropy and the consequences of the Second Law tend to remain rather neutral in their tone. Yet Helmholtz intimates its profoundly disturbing potential when he asks, "Shall we terrify ourselves by this thought?" and concludes stoically that "[a]s each of us singly must endure the thought of his death, the race must endure the same."[10] The attachment of a distinctly negative value to entropy emerges more clearly in later developments.

8 Hermann von Helmholtz, "On the Interaction of Natural Forces," in *Science and Culture: Popular and Philosophical Essays*, ed. David Cahan (Chicago and London: University of Chicago Press, 1995), 30.

9 Clausius, *Über den zweiten Hauptsatz der mechanischen Wärmetheorie* (Braunschweig: Vieweg, 1867), 17.

10 Helmholtz, "On the Interaction of Natural Forces," 41–2, 43.

1.2 Schrodinger's Life

In February 1943, the physicist Erwin Schrödinger gave a series of lectures at Trinity College, Dublin, on the topic *What is Life?* The short book based on these lectures became one of the most influential popular science books of the twentieth century. Here Schrödinger explains life in a way which opposes it to entropy. Life is that which *resists* entropy, slowing down the action of the Second Law. What distinguishes living things from inert matter is their tendency to go on doing things, to resist the inert state that comes with thermal equilibrium.[11] Living beings avoid, or at least postpone, this decay by *metabolising* food that they take in from their environment. Schrödinger specifies that the Greek root of the term "metabolism" means change or exchange.[12] Organisms retain the capacity to go on *changing* by *exchanging* with their environment.

In answer to the question of *what* exactly organisms take in from their environment (as food), Schrödinger rejects prevailing answers in terms of matter or energy and proposes that what organisms feed on is "negative entropy." He explains:

> What then is that precious something contained in our food which keeps us from death? That is easily answered. Every process, event, happening - call it what you will; in a word, everything that is going on in Nature means an increase of the entropy of the part of the world where it is going on. Thus a living organism continually increases its entropy - or, as you may say, produces positive entropy - and thus tends to approach the dangerous state of maximum entropy, which is death. It can only keep aloof from it, i.e. alive, by continually drawing from its environment negative entropy - which is something very positive as we shall immediately see. What an organism feeds upon is negative entropy.[13]

After introducing the term "negative entropy," Schrödinger suggests that it can be replaced with the term *order*.[14] Entropy itself is then equated with disorder, or chaos. Life is a process through which living beings compensate for the entropy they produce by "sucking orderliness" from their environment.[15] In a later note addressing criticisms of his term "negative entropy," he suggests that if his sole audience were physicists, he would have used the term "free energy" instead.[16] As it is, Schrödinger"s work was very influential in introducing the idea of life as associated with a "negative entropy" (later

11 Erwin Schrödinger, *What is Life?* (1944) (Cambridge: Cambridge University Press, 1967), 68.
12 Schrödinger, *What is Life?* 70.
13 Schrödinger, *What is Life?* 71.
14 Schrödinger, *What is Life?* 73.
15 Schrödinger, *What is Life?* 73.
16 Schrödinger, *What is Life?* 74.

shortened to "negentropy" by Léon Brouillon)[17] and equating entropy with disorder and death. After Schrödinger, if we fear death, then we may believe we need to fear entropy.

1.3 Wiener's Cybernetics

In his development of the transdisciplinary science of cybernetics, Norbert Wiener contextualises the analogy it makes between living beings and machines in a larger physics and metaphysics of order and disorder (entropy). The analogy itself, which is exemplified by automata, is based on the idea of information as the means of communication and control in systems of all kinds, including living beings and machines. Wiener, along with Claude Shannon, developed a mathematical theory of information which follows the statistical mechanics developed in the nineteenth century for thermodynamics. The *probabilistic* nature of information allows basically the same equation to be used to measure information as that which has become known as "Boltzmann's principle," which measures entropy in thermodynamics.[18] Wiener explains:

> The notion of the amount of information attaches itself very naturally to a classical notion in statistical mechanics: that of *entropy*. Just as the amount of information in a system is a measure of its degree of organization, so the entropy of a system is a measure of its degree of disorganization; and the one is simply the negative of the other.[19]

In Wiener's cybernetics, information and all systems which use it to increase order can be understood in terms of negative entropy, while disorder is understood as entropy.

Similarly to Schrödinger's understanding of life, Wiener understands living beings as increasing order in local systems, despite the inevitable increase of disorder in the more global systems of which they are a part, and he extends this notion of "anti-entropic" processes[20] to machines insofar as they are able to increase order:

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17 Léon Brillouin, "Negentropy Principle of Information," *Journal of Applied Physics* 24, no. 9 (1953): 1152–1163.

18 In fact developed in its final form by Max Planck, but so associated with Boltzmann that it is inscribed on his tombstone. The equation for the principle is $S = k \log W$, where S stands for entropy, k is a constant ("Boltzmann's constant," also first stated explicitly by Planck), and W, the number of microstates in a system.

19 Norbert Wiener, *Cybernetics*, 2nd Ed. (Cambridge, Mass: MIT Press, 2019), 17.

20 Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society*, 2nd Edition (London: Free Association Books, 1989), 32.

> The machine, like the living organism, is, as I have said, a device which locally and temporarily seems to resist the general tendency for the increase of entropy. By its ability to make decisions it can produce around it a local zone of organization in a world whose general tendency is to run down.[21]

It is in this context that Wiener names entropy as the "arch-enemy"[22] of the cause of order, of progress and civilization, not only in a local and temporary sense, but because of the heat death that the Second Law predicts. The Second Law will mean that order is ultimately destined to disorder, life to death, and Wiener characterises entropy as a "devil."[23] Drawing on theological traditions, he argues that this devil has an Augustinian nature rather than a Manichean one. This means that entropy/evil is not to be understood as a substantial counter-tendency to good (the Manichean "heresy"), but rather as simply a lack, privation, or negation of good, as Augustine contends. Entropy is then simply a lack of order. Wiener furthermore names this devil Mephistopheles, referencing characteristics ascribed to him in Goethe's *Faust*, suggesting that he is not a fully independent and unlimited force of evil, but only a deprivation of good.[24] Wiener conceives his project of cybernetics as part of the broader struggle against entropy (understood as disorder or disorganisation), which he theorises by drawing analogies with theology, explicitly demonising entropy in the process.

1.4 Stiegler's Negathropology

Far from the diabolical character of entropy having disappeared from more recent literature, its profile seems to have been raised. This is evident in the work of Bernard Stiegler, who, in the years before his recent and untimely death, identified entropy as the negative value in his own original philosophy. This philosophy encompasses a global metaphysics of systems and individuals ("organology"), with a particular emphasis on how things "individuate," or become what they are. Stiegler is concerned with human individuals in their psychological and affective constitution, technologies, societies in general, and the earth with its manifold economic, political, and environmental problems. Stiegler's "organology," or "neganthropology," is a kind of energetic systems theory, in which negentropy is identified as the general "good," and entropy the general "evil." In this,

21 Wiener, *Human Use*, 34.
22 Wiener, *Human Use*, 34.
23 Wiener, *Human Use*, 34.
24 Wiener, *Human Use,* 35.

Stiegler is influenced by earlier scientists and philosophers such as Schrödinger, Alfred J. Lotka, and Nicholas Georgescu-Roegen,[25] but his thinking is also subtly complexified by the influence of Nietzsche.

Stiegler describes the individuation process in general in terms of tendencies which are contrary, but "composing" rather than simply opposing in an antagonistic sense. Inspired by Nietzsche, Freud, and others, he identifies this "compositional" way of thinking as present in early Greek thinking, prior to the imposition of metaphysical, oppositional thinking (with Socrates, Plato, and Aristotle). It is, for example, present in Heraclitus's "unity of opposites," and it is this mode of non-oppositional thought which inspired Nietzsche's thinking, first of the complex, productive intertwining of Apollonian and Dionysian tendencies, and then in thinking "beyond good and evil," understood to be moral oppositions isomorphic to metaphysical ones. Stiegler associates this compositional mode as essential to healthy individuation processes and to life itself.

However, Stiegler reintroduces evil, and entropy as a principle of evil (or simply negative value), in order to explain what goes wrong with individuation processes. Even though "disindividuation," and entropy in some sense, are essential to healthy individuation processes, they can shift out of balance with their opposing tendency and become dominant, leading to the destruction of the healthy individual. One way Stiegler explains this is with recourse to the double nature of *Eris*, the goddess of discord, indicated by Hesiod at the beginning of *Works and Days*, to which Nietzsche drew attention in his early essay "Homer's Contest." One of the natures of *Eris* is as the goddess of competition, who motivates the accomplishment of great deeds. This is a healthy and productive kind of agonism, strife, or discord. However, this very same tendency can transform into its worst aspects, in which it becomes the other *Eris*, the goddess of war and destruction.[26] Applying this principle to thermodynamic ideas, Stiegler acknowledges that metastability, the state of potential energy necessary for further individuation, is a state between order and disorder, containing them both in tension. But disindividuation is then associated with the tendency to disorder, or entropy, which can break away from this productive

25 Georgescu-Roegen's work in economics established a position known as "entropy pessimism," which further demonises entropy. In short, he argues that the Earth's resources are finite, and do not support any economic model of infinite growth. While aspects of his understanding of physics have been challenged (he believed the Second Law can be applied to physical matter in the same way as to energy, which is not the scientific orthodoxy), his basic position of "entropy pessimism" continues to be influential in environmental circles, as well as being an important influence on Stiegler's philosophy. See Nicholas Georgescu-Roegen, *The Entropy Law and the Economic Process* (Cambridge, Mass: Harvard University Press, 1971).

26 See Stiegler, *The Decadence of Industrial Democracies*, trans. Daniel Ross (Cambridge: Polity, 2011), 50–53 (section 5. "The worst and the best in the epoch of nihilism as questions of war and class struggle") and *Acting Out*, trans. David Barison (Stanford: Stanford University Press, 2008), 73–75 (the section "The question of evil and the thought of tendencies").

interaction, become dominant, and simply destructive.

While Stiegler warns against "diabolising" the tendency against which one fights,[27] in his later works his polemical rhetoric hardly holds back from presenting "entropy" as the general, overwhelming problem, the principle of evil and diabolism itself. This is encapsulated in his coining of the term "Neganthropology"—which is in part drawn from "negentropy," the opposite of entropy—to indicate all that we must fight for in order to overcome the destructive tendencies he sees as characteristic of the Anthropocene (which he also calls the "Entropocene"[28]) and threatening the human race with extinction in multiple ways. According to Stiegler, with entropy:

> the question of evil resurfaces, and it does so macrocosmologically—and not morally—after the Nietzschean attempt to leap (*Sprung*) beyond good and evil, and as the threat from within the biosphere to the biosphere itself.[29]

1.5 Floridi's Information Ethics

Neither is the demonisation of entropy restricted to the "literary" dramatisations of the continental philosophical tradition. Luciano Floridi does not hesitate to explicitly identify entropy and evil in his account of ethics within the systematic exposition of his philosophy of information.[30] He more lately regrets the choice of the term "entropy," but only because of the confusion it his caused his readers in relation to the way the term is used in thermodynamics and Shannon's information theory.[31] He in fact doubles down on the metaphorical association of entropy with evil in its theological dimensions, broadly following Wiener. In order to distinguish it from thermodynamics and information theory, Floridi clarifies that entropy in Information Ethics (IE) doesn't refer to energy (thermodynamics) or formal syntax (information theory), but to the degradation of information in its *semantic* or *ontological* dimension: that is, it concerns information *content* (meaning, or being). In order to further clarify what he means, Floridi proposes to call this *metaphysical entropy*, which he explains as follows:

27 Stiegler, *Acting Out*, 73–4.

28 See Stiegler, "Capitalism as Epistēmē and Entropocene," in *The Neganthropocene*, ed. and trans. Daniel Ross (London: Open Humanities Press, 2018).

29 Stiegler, *Neganthropocene*, 196.

30 Floridi now describes himself as a "former" analytic philosopher and positions his own philosophy of information beyond the divide. Yet his work remains rooted in this tradition and continues to display many of its norms.

31 Luciano Floridi, *The Ethics of Information* (Oxford: Oxford University Press, 2013), 65–66.

> Metaphysical entropy refers to any kind of destruction or corruption of entities understood as informational objects (mind, not just of semantic information, or messages), that is, any form of impoverishment of Being.[32]

Floridi proposes that a fundamental positive value be accorded to any and all information, such that any informational entity has a minimal value (i.e., is considered "good") in its simple existence. Any degradation of information is then construed as an ethical *evil*. In a move reminiscent of Wiener, he then suggests that evil has only a negative, or privative, meaning: Being is good, and Non-Being, or nothingness, is evil. Entropy, as the degradation of information, is thus considered evil in informational terms.

This thesis, Floridi says, follows the classical notion of evil as *privatio boni*: only good has substantial reality, and evil is simply the negation, destruction, or corruption of a positive good.[33] Again following Wiener (knowingly or not), Floridi quotes Goethe's Mephistopheles in support of the "negative" character of evil as Non-Being:

> I am the Spirit, that ever denies!
> And rightly so; for everything that comes into being, deserves to perish;
> since it were better if nothing had come forth.
> Thus is everything that you call Sin,
> Destruction, in short, Evil,
> my proper Element.[34]

Floridi develops his notion of entropy as evil by specifying four ethical principles of IE, the first three of which give us normative statements regarding entropy:

> 0 entropy ought not to be caused in the infosphere (null law)
> 1 entropy ought to be prevented in the infosphere
> 2 entropy ought to be removed from the infosphere
> 3 the flourishing of informational entities as well as the whole infosphere ought to be promoted by preserving, cultivating, and enriching their well-being.[35]

It would be hard to imagine a much more explicit "demonisation" of entropy than Floridi's evocation of its Mephistophelean character, his bald characterisation of entropy *as* evil, and

32 Floridi, *Ethics of Information*, 67.
33 Floridi, *Ethics of Information*, 67.
34 Goethe, *Faust*, I, 1338–44. Floridi's translation; see: *Ethics of Information*, 67.
35 Floridi, *Ethics of Information*, 71.

its normative ethical proscription.[36] Yet we can see Floridi's position as a condensation of multiple tendencies towards the demonisation of entropy, and while he develops a unique "informational" notion of entropy, its characterisation as evil draws on many precursors who, as we have seen, have established this metaphysical, moral, and affective association.

2. The Case of Nietzsche

The above examples of the "demonisation" of entropy may be thought of—whether or not this appears consciously in the writers concerned—as instances of *naturalising values*. Nietzsche sets out the project for a naturalisation of values when he examines the inadequacy of the current state of values in nineteenth century Europe. God was dead; the transcendent source of values had been seriously placed in question. However, Nietzsche complained, the values prevailing in European culture continued, as if by inertia, to be the "highest values" inherited from the Christian and metaphysical traditions. The project Nietzsche then sets out is to "naturalize" values by finding a new basis for them *in nature*, rather than in some transcendent supernatural source. In *Gay Science* 109, he writes:

> When will all these shadows of God cease to darken our minds? When will we complete our de-deification of nature? When may we begin to "*naturalize*" humanity in terms of a pure, newly discovered, newly redeemed nature?

For Nietzsche, science—the study of nature—is a major source of inspiration for the discovery of new principles of value. For example, he claims to find "the will to power" everywhere in living things and was partially inspired in this idea by Boscovitch's theory of the atom.[37]

Stiegler clearly announces the way that entropy can be understood to have played a role in the naturalisation of values:

> Emerging from thermodynamics about thirty years after the advent of industrial technology […] the theory of entropy succeeds in redefining the question of *value*.[38]

36 In addition to the sections of *The Ethics of Information* cited, see Floridi, Luciano and J.W. Sanders, "Entropy as Evil in Information Ethics," *Etica & Politica* 1, no. 2 (1999) <http://www2.units.it/etica/1999_2/index.html>.

37 Z:II "Self-Overcoming." On Nietzsche and Boscovitch, see for example Greg Whitlock, "Roger J. Boscovitch and Friedrich Nietzsche: A Re-Examination," in *Nietzsche, Epistemology and Philosophy of Science*, ed. Babette E. Babich (Dordrecht: Springer, 1999).

38 Bernard Stiegler, *Automatic Society 1: The Future of Work*, trans. Daniel Ross (Cambridge: Polity Press, 2016), 10.

Nietzsche engaged with the ideas of thermodynamics and entropy, and notably he rejected the Second Law, or at least its apparent implication of heat death.[39] In a recent article, Joel White argues that this rejection was motivated by a kind of *ressentiment* against the idea of heat death.[40] He summarises his interpretation as follows:

> Nietzsche's hatred for the so-called "metaphysical" and will to overcome nihilism determine a resentful attitude towards entropic death that ultimately takes refuge in the *deus ex machina* of perpetual motion. It is hard to think of anything more counter to Nietzsche's own criticisms of the history of metaphysics than the use of perpetual motion as the means of energetically conditioning the eternal return. The affirmation of the eternal return as an affirmation that seeks the transvaluation of values is affirmed not for itself but for "ulterior motives," ones that begin and end in ressentiment, for it is not a yes-saying but a no-saying to heat death by any means necessary, metaphysical, or not. For what could be more reactive than the foolhardiness of those that continue to believe in ideas such [as] *perpetuum mobile*, the law of identity in mechanical form, despite it being both practically and theoretically disproved?[41]

I do not believe *ressentiment* against the idea of heat death is a fair characterisation of Nietzsche's reasons for rejecting it. To see why, let us first consider the argument itself, then its context.

Nietzsche rejected heat death (without naming it as such) in so far as it implies a final state. The argument draws on multiple authors in these debates, and their philosophical and scientific heritage, but most significantly on Schopenhauer's argument *a parte ante* ("from the part before") for the impossibility of an infinite time having already passed before the present moment.[42] Nietzsche presents the argument as follows:

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39 A great deal of credit must be given to Paolo D'Iorio for advancing our understanding of Nietzsche's idea of the eternal return by painstakingly reconstructing the context of the scientific and philosophical debates around the Second Law from which they emerged. See Paolo D'Iorio, "Eternal Return: Genesis and Interpretation," trans. Frank Chouraqui, *The Agonist* 3, no.1 (2010): 1–43. Stiegler discusses Nietzsche and entropy, and D'Iorio's interpretation specifically, in *L'immense régression*, section 55: "Nietzsche et la mauvaise nouvelle de l'entropie" [Nietzsche and the Bad News of Entropy], 408–416 [digital edition].

40 Joel White, "How Does One Cosmotheoretically Respond to the Heat Death of the Universe?" *Open Philosophy* 6, no. 1 (2023): 2022–0233. Despite the point of disagreement regarding the interpretation of Nietzsche that follows in the text above, my conclusion at the end of this analysis is the same as White's: given its persistent scientific status, the consequences of the Second Law cannot simply be denied on "metaphysical" grounds, which can easily appear as flimsy as imaginative wish-fulfilment when placed against the (at least relatively) firm edifice of scientific evidence.

41 White, "How Does One Cosmotheoretically Respond."

42 Again, this has been meticulously reconstructed by D'Iorio. See D'Iorio, "Eternal Return."

> If the world could in any way become rigid, dry, dead, *nothing*, or if it could reach a state of equilibrium, or if it had any kind of goal that involved duration, immutability, the once-and-for-all (in short, speaking metaphysically: if becoming *could* resolve itself into being or into nothingness, then this state must have been reached. But it has not been reached. From which it follows—[43]

The sentence breaks off, but clearly what follows is that a final state is not possible. If it were, it would already have been reached since there has already been an infinite time in which to accomplish such a state. Nietzsche then builds his "cosmological" argument for the eternal return on this basis, adding the idea of a definite quantity of force to that of infinite time: given this, every possible combination of force must repeat an infinite number of times (eternally return).[44] He suggests that this is demanded by the First Law of thermodynamics, that of the conservation of energy.[45]

Nietzsche's choice of eternal return over heat death needs to be understood in the context of *pessimism*, the Schopenhaurian philosophy which initially attracted him but which he spent the rest of his intellectual life trying to overcome. The image of existence that Nietzsche seeks to affirm is in many respects precisely the image that plunged Schopenhauer into pessimism, and which the latter thought needed to be "negated" or "denied." For example, Schopenhauer writes: "Eternal becoming, endless flux belong to the revelation of the essential nature of the will."[46] For Schopenhauer, the will is the fundamental nature of reality, and its character consists in a restless drive that can never be satiated. The will determines human life as essentially incapable of fulfilment, fluctuating between suffering and boredom. The "eternal becoming and endless flux" which characterise the will are, here, reasons for pessimism. A "heat death" of the universe would remove these reasons, resulting in a kind of consolation from this deepest of pessimistic views. D'Iorio explains very clearly why the pessimist is consoled by the thought of heat death:

> interpreting Schopenhauer's concept of will as a "not being able to not will," as an eternal willing creating an infinite process in the past and in the future, would

43 WP 1066. Here and following I quote from *The Will to Power*, despite its notorious unreliability, because many of the relevant passages are not yet available in more reliable English translations. In the few cases where there are alternatives available, I have also cited them, but have selected all quoted text from *The Will to Power* for the sake of consistency and clarity.

44 WP 1066.

45 WP 1063/WLN 5[54].

46 Arthur Schopenhauer, *The World as Will and Representation*, vol 1, trans. E.F.J. Payne (New York: Dover, 1966), 164 (section 29).

> lead one to despair, because this would suppress the possibility of a liberation from the senseless impulse of the will.[47]

Schopenhauer, who died in 1860, did not significantly engage the philosophical debates on thermodynamics, which became popular in Germany only after Clausius' 1867 lecture *Über den zweiten Hauptsatz der mechanischen Wärmetheorie* [On the Second Principle of the Mechanistic Theory of Heat].[48] But the pessimistic position was prominently represented in these debates by Schopenhauer's follower Eduard von Hartmann. In the latter's 1869 book *Philosophy of the Unconscious*, he argues that the absence of pain is the best possible happiness.[49] This position led him into debates about heat death, where his aim was to argue in favour of its reality, because for him it constituted an ultimate liberation from suffering. What he wanted to avoid was precisely the notion of an eternal return, where the cycle of life might start again, and with it the pain of existence.

In light of this pessimist context, Nietzsche's thesis of eternal return then appears as what it is: a challenge to the pessimist thesis, which deprives the pessimist of their hope for a final "liberation" from existence. In Nietzsche's words: "Everything becomes and recurs eternally—escape is impossible!"[50] Against White's interpretation, I would emphasise that Nietzsche's aim with the eternal return is not to present a comforting idea to ward off an unpalatable one, but precisely the opposite: the eternal return is designed to present life in such a way that there is *the greatest difficulty* in affirming it. This is what Nietzsche means, for example, in characterising the thought of eternal return as "*the heaviest burden*"[51] and "the *hardest* idea."[52] In characterising Nietzsche's position as reactive and motivated by *ressentiment*, White misses this aspect. If Nietzsche found heat death an abhorrent thought that he felt *ressentiment* towards, then that would in fact have been reason to *prefer* it over the hypothesis of eternal return for the role it is intended to play as an existential "test." As Pierre Klossowski has emphasised, the idea of the eternal return acts as a "selective doctrine," which establishes the difference between "higher types" (those who can affirm it) and the rest of humanity (those who cannot).[53] For Nietzsche, "the eternal return" is

47 D'Iorio, "Eternal Return," 23.

48 Clausius, *Über den zweiten Hauptsatz*. The importance of this lecture is noted by D'Iorio, "Eternal Return," 40.

49 Eduard von Hartmann, *Philosophy of the Unconscious*, trans. William Chatterton Coupland (London and New York: Routledge, 2014). See for example the section "Nature of the Problem" in chapter XIII, where Hartmann asserts that someone who, on the point of death, had the chance to live their life over again, would most likely prefer non-existence. (D'Iorio highlights the relevance of this thought experiment to Nietzsche's eternal return.)

50 WP 1058.

51 GS 341.

52 WP 1059.

53 Pierre Klossowski, *Nietzsche and the Vicious Circle*, trans. Daniel W. Smith (Chicago: University of Chicago Press, 1997), chapter 6: "The Vicious Circle as a Selective Doctrine."

"the highest formula of affirmation that can possibly be attained."[54] My contention, in short, is that Nietzsche was not concerned that the Second Law was *too nihilistic*, but that it was *not nihilistic enough* to present the ultimate test—because the thought of ultimate annihilation is exactly what is comforting to pessimists like Schopenhauer or Hartmann. Nietzsche affirmed eternal return *because it is the more difficult position to affirm*, and it thus achieves the highest affirmation. The thought of Eternity is a *terrible test*; it should in fact be *easier* to affirm heat death. Uncovering Nietzsche's specific motivations for rejecting heat death then clears the way for a Nietzschean affirmation of entropy. In the following, I will presents reasons why we might believe not just that this is possible, but necessary.

3. The Scientific Spirit

Nietzsche's relation to science, and to purported "scientific facts," is a complex and contested matter, but the presence of a certain privileging of the "scientific spirit" over the "religious" or "metaphysical" in his works is well-attested. In general, he wished to pursue and accentuate "the recently attained preponderance of the scientific spirit over the religious."[55] In this scientific spirit, then, to interpret Nietzsche's philosophy according to its own guiding lights we should place his views on entropy and heat death in the context of the scientific knowledge of his time and compare it to our own.

Now, Nietzsche's argument is that *all things being equal* with respect to scientific evidence, we can argue the merits or demerits of various cosmological models on the basis of speculative metaphysical arguments, combined with value judgements. This, I think, can be read from the note published as *The Will to Power* 1066, in which Thomson's and Düring's views on heat death are discussed, and where he presents the argument about infinite time *a parte ante* as follows:

> Nothing can prevent me from reckoning backward from this moment and saying "I shall never reach the end"; just as I can reckon forward from the same moment into the infinite.

With respect to value judgements, he notes that wherever he has found the argument for a finite time prior to the present moment, "every time it was determined by other ulterior considerations (—mostly theological, in favour of the *creator spiritus*)." He then continues to elaborate the argument *a parte ante*, in a passage already quoted above, and makes the

54 EH "Books" Z.
55 WP 1062/UF 36[15].

important point:

> This is the *sole certainty* we have in our hands to serve as a corrective to a great host of world hypotheses *possible* in themselves. If, e.g., the mechanistic theory cannot avoid the consequence, drawn for it by William Thomson, of leading to a final state, then the mechanistic theory stands refuted.[56]

In short, this is a metaphysical and logical argument made in the context of a lack of *scientific* evidence which would decide between various "world hypotheses." However, we now have much more scientific evidence, giving weight to a certain hypothesis (or class of hypotheses). Here, I would point to two important issues: first, there is the weight of the general acceptance of the Second Law itself. Second, there is the dating of the universe, which is the single most important development in cosmology since Nietzsche's time, and gives significant privilege to certain "world hypotheses," while diminishing the plausibility of others (or, more strongly put, falsifying them). We are no longer in the same situation with respect to "a great host of world hypotheses possible in themselves."

Both of these issues are to some degree still open to debate, but are nevertheless compelling in making certain contrary hypotheses appear very unlikely. While some scientists are still not entirely convinced,[57] for the most part today the scientific consensus seems to be in step with the sentiments Arthur Stanley Eddington famously expressed in 1927:

> The law that entropy always increases—the second law of thermodynamics—holds, I think, the supreme position among the laws of Nature. If someone points out to you that your pet theory of the universe is in disagreement with Maxwell's equations—then so much the worse for Maxwell's equations. If it is found to be contradicted by observation—well, these experimentalists do bungle things sometimes. But if your theory is found to be against the second law of thermodynamics I can give you no hope; there is nothing for it but to collapse in deepest humiliation.[58]

The great breakthrough in dating the universe was made by astronomical observations

56 WP 1066; emphasis added.

57 See for example Roger Penrose, *The Road to Reality* (New York: Vintage, 2005), 692, and Sabine Hoffenfelder, "I Don"t Believe the 2nd Law of Thermodynamics (The Most Uplifting Video I'll Ever Make)," YouTube, 2023.

58 Arthur Stanley Eddington, *The Nature of the Physical World* (Cambridge: Cambridge University Press, 1929), 74.

combined with spectrum analysis, and published by Edwin Hubble in 1929.[59] This supported a model of the universe as expanding, and hence implied a point and a time from which it began to expand (an "origin"). Today there is what some believe to be a "crisis" in cosmology, because two different methods of dating the universe—by measuring cosmic background microwave radiation, and by measuring distances between observable astronomical phenomena (stars and galaxies)—give us different results (18.8 and 14.5 billion years, respectively).[60] Nevertheless, they both point to an origin, so whichever turns out to be more accurate, together they stand against the hypotheses of an infinite past. This evidence supports the Second Law of thermodynamics, and for us today, reverses Nietzsche's available argumentation. While he could hold (perhaps quite plausibly) that the argument of infinite time *a parte ante* decides against the Second Law, today the combined weight of the Second Law and the dating of the universe means we should rather say that because of these, we can know that an infinite time has *not* elapsed prior to the present moment.[61] Nietzsche's "sole certainty" for choosing between cosmological hypotheses is no longer tenable, and in the interests of the scientific spirit we should reject any hypotheses which contradict the weight of current evidence, including Nietzsche's own.

4. Beyond Good and Evil

I take the above scientific considerations to be sufficient reason to affirm entropy. To do so is in keeping with a Nietzschean "scientific spirit," which compels us to reassess Nietzsche's own conclusions in light of the evidence we now have available concerning cosmology. In this and the following section, however, I will further consolidate the argument by respectively 1) "deconstructing" the oppositions which have stabilised the attachment of the values of "good" and "evil" to negentropy and entropy; and 2) argue that from the perspective of Nietzsche's own interpretive attempts to naturalise values, we have good reasons to affirm entropy as consonant with his vision.

59 Edwin Hubble, "A Relation between Distance and Radial Velocity among Extra-Galactic Nebulae," *Proceedings of the National Academy of Sciences* 15, no. 3 (1929): 168–173.

60 E. Di Valentino, A. Melchiorri, and J. Silk, "Planck Evidence for a Closed Universe and a Possible Crisis for Cosmology," *Nature Astronomy* 4, no.2 (2019): 196–203.

61 As Paul Davies, for example, writes: "The fact that the universe has not yet so died—that is, it is still in a state of less-than-maximum entropy—implies that it cannot have endured for all eternity." *The Mind of God* (London: Penguin, 1992), 47.

4.1 Beyond Order and Chaos

On the basis of the common characterisation of negentropy as order and entropy as disorder, we can see a co-implication, rather than opposition, of these tendencies in both "traditional" equilibrium thermodynamics, and the more recent science of far-from-equilibrium systems. While, as I have emphasised, entropy has often been demonised, scientists have also not uncommonly presented it as what *makes possible* negentropic order. The production and maintenance of order *always* comes at the cost of entropy production. And the relations between these have long been described in terms of open, "coupled systems." While the Second Law dictates that entropy always tends to increase in *closed* systems, the creation and maintenance of order is possible in an *open* system when it channels the entropy it produces into a larger system with which it is in communication.[62] (An oft-repeated example is a fridge, which maintains a temperature lower than its environment by channelling the heat it produces into that environment.) The production of local order in coupled systems does not contravene the Second Law, because the overall entropy in the coupled systems—and in the universe as a whole—still increases. Another way of seeing this point is to say that it is the process of the dissipation of energy itself which can be "harnessed" to create order.[63] Negentropic order and entropic disorder are then co-implicated processes, and from this point of view it makes little sense to positively value negentropy and negatively value entropy in an exclusive manner, as though we would be "better off" without the latter.

An even deeper complication and co-implication has been introduced by far-from-equilibrium thermodynamics. This area, pioneered by Ilya Prigogine, challenges the exclusive attachment of order to negentropy and disorder to entropy by having identified "dissipative structures," in which order surprisingly emerges from entropic processes, contravening Boltzmann's principle. Boltzmann formulated thermodynamics in terms of heat understood as atomic agitation, and the probabilities of the distribution of these atoms: entropy is then understood as tending to increase because there are many more probable states of "disorder" than of order, and thermal agitation encourages the disordering of physical arrangements. With dissipative structures, however, we have highly improbable states of order arising from processes involving a high degree of dissipation (entropy). An example here is Bénard convection cells, where the dissipated state of energy in the agitated atoms of a heated fluid spontaneously give rise to ordered patterns. In the words

62 These terms are sometimes used with different meanings in the scientific literature. Here I am using "closed" system to mean a system in which neither energy nor matter is exchanged with an outside, and "open" system to mean one in which both can be exchanged. (Sometimes the term "isolated" system is used in place of this meaning of "closed" system, while the term "closed" is used to refer to a system which is open to exchanges of energy, but not of matter.)

63 *Order and Disorder*, Episode 1: *Energy*, BBC, 2012.

of the English translation of Prigogine and Isabelle's Stenger's popular book on the topic, nature is capable of producing "order out of chaos."[64]

Interestingly, this close relation between order and chaos is nothing radically new, neither in thermodynamics nor in mythology, religion, and philosophy.[65] The features of the latter which the former seems to invoke were already noted by Helmholtz, who was in fact the first to evoke the demon Mephistopheles in conjuring the concept of entropy, but in a distinctly less diabolical aspect than the later manifestations we have already encountered:

> [I]n what close coincidence the results of science here stand with the earlier legends of the human family, and the forebodings of poetic fancy. The cosmogony of ancient nations generally commences with chaos and darkness. Thus for example Mephistopheles says:-
>
> > Part of the Part am I, once All, in primal night,
> > Part of the Darkness which brought forth the Light,
> > The haughty Light, which now disputes the space,
> > And claims of Mother Night her ancient place.[66]

Both the science and the myth suggest that entropy, as a principle of chaos, is entwined with rather than opposed to negentropic order. The key point is that the close connections between negentropy and entropy in both traditional and far-from-equilibrium thermodynamics challenge the simple association of the values of "good" and "evil" (or simply "bad," "worse," etc.) to each respectively.

4.2 Beyond Life and Death

> Consumed by lust, O Man, do not forget: you—are the stone, the desert,
> you are death . . .
>
> —Nietzsche, "The Desert Grows," *Dithyrambs of Dionysus*

64 Ilya Prigogine and Isabelle Stengers, *Order out of Chaos* (London: Flamingo, 1985). For the Bénard convection example, see page 142.

65 On order and chaos in ancient Greek mythology and philosophy, see Shannon M. Mussett, *Entropic Philosophy: Chaos, Breakdown, and Creation* (Lanham: Rowman & Littlefield, 2022), chapter 2.

66 Helmholtz, "On the Interaction of Natural Forces," 34–35.

A further case may be made for challenging the oppositional logic which informs the thought of entropy in the context of *life*. As we have seen, Schrödinger was highly influential in characterising life as a negentropic process, and correspondingly associating entropy with death. Now, despite his affirmation of "life" in an *existential* sense, Nietzsche is wary of any oppositional vitalism, of the kind that Schrödinger seems to endorse. For example, in Nietzsche's writings we find the following:

> Let us beware of saying that death is opposed to life. The living is merely a type of what is dead, and a very rare type.[67]

This is a complex point, since what Nietzsche would seem to be opposed to is the kind of vitalism which retains theological and anthropomorphic resonances in proposing something unique and perhaps "supernatural" that distinguishes living from unliving matter.[68] Certainly, Schrödinger's theory of life is no nineteenth-century vitalism of this kind.

The complexities of Nietzsche's views on life, compared with more recent theories, are not something I can do justice to here. Nevertheless, whatever Nietzsche might have meant by "life," it is highly implausible that he meant "order," or something else seemingly cognate with the notion of negentropy. This can hardly be what he meant by identifying his "message" with the Dionysian. If we had to characterise Nietzsche's position in terms of the oppositional choice the negentropic theory of life gives us, affirming life for Nietzsche means to a much larger extent affirming disorder, and even affirming death, than affirming something like "life as order." In light of the points about the revaluation of destruction, chaos, and so on we noted above, the *challenge* Nietzsche sets us with the injunction to affirm life is much better expressed with the affirmation of entropy.

Moreover, Nietzsche privileged "life" in an existential sense which is not reducible to a concern for the preservation of the biological organism. This is quite evident in his comments that beings with a high degree of will to power are concerned only to express that power, even at the potential cost of their own continued existence. For example, he writes:

> To wish to preserve oneself is a sign of distress, of a limitation of the truly basic life-instinct, which aims at the expansion of power and in so doing often enough

67 GS 109.

68 On Nietzsche's dissatisfaction with both mechanism and vitalism, see Christoph Cox, *Nietzsche: Naturalism and Interpretation* (Berkeley: University of California Press, 1999), section 5.2.5.

> risks and sacrifices self-preservation.[69]

Nietzsche also puts this message into the mouth of Zarathustra, who proclaims of the will to power:

> I would rather perish than renounce this one thing; and truly, wherever there is decline and the falling of leaves, behold, there life sacrifices itself—for power![70]

Since, as we have noted, all energetic processes tend towards dissipation (entropy production), life-affirming expressions of will to power could well be understood as consonant with entropic processes leading to the complete dissipation of the forces constituting the organism (death).

4.3 Beyond Order and Disorder

We have so far deconstructed the *opposition* between entropy and negentropy, understood as order and disorder. Arguably, it is the characterisation of these physical principles as "order" and "disorder" which have so readily allowed evaluative associations and judgements to be made concerning them. Helmholtz was among the earliest to explicitly make this association, calling entropy "disorder" (*Unordnung*) in 1882,[71] and it subsequently taken up by Boltzmann and became widespread in both scientific and popular discourse. More recently, however, this association has been questioned, and some scientists are preferring to stick to terms such as "dissipation," "dispersal," and "spread" to characterise entropy. The notions of order and disorder have increasingly become recognised as subjective judgements, with limited clear applications in mathematical and physical description. Georges Chapoutier has argued that while disorder may be rigorously defined according to a statistical analysis of particles in particular cases, such as the theory of gases, there is no reason to think that this holds for more complex phenomena, and no way to quantitatively distinguish more ordered from less ordered systems in most cases.[72] Even more radically, Frank L. Lambert has waged a campaign (with some success) to have the description of entropy as disorder removed from textbooks. He cites the fact that this

69 GS 349.

70 Z:II "Self-Overcoming."

71 Helmholtz, "Ueber Die Thermodynamik Chemischer Vorgange," [On the Thermodynamics of Chemical Processes] in *Wissenschaftliche Abhandlungen*, vol. 2 (Leipzig: Barth, 1833), 972.

72 See Georges Chapouthier, "Information, structure and forme dans la pensée de Raymond Ruyer," *Revue Philosophique de la France et de l'Étranger* 203, no. 1 (2013): 21-23 and Jean-Jacques Matras and Georges Chapouthier, "La néguentropie: un artefact," *Fundamenta Scientiae* 5, (1984): 141–151.

formulation was influentially used by Boltzmann prior to quantum mechanics, when he did not have a valid way to quantitatively calculate microstates, and when the existence of atoms was not widely accepted. Consequently, Boltzmann had to focus on systems at a "macro" level, and this made his metaphoric description of entropy as "disorder" a more plausible way to grasp the concept intuitively at the time (1898) than we have a right to sustain today. In short, Lambert unequivocally asserts:

> Entropy is not disorder. Entropy is not a measure of disorder or chaos. Entropy is not a driving force. Energy's diffusion, dissipation, or dispersion in a final state compared to an initial state is the driving force in chemistry. Entropy is the index of that dispersal within a system and between the system and its surroundings.[73]

Order and disorder are largely aesthetic and practical judgements, made from a subjective, human perspective. It is these judgements to which moral values are then attached, according to human aims, interests, and feelings of pleasure and pain. The difficulty in ascribing judgements of order and disorder in an objective sense may be given with a simple example, which is sometimes seen in the literature: whether milk poured into coffee increases or decreases order in the universe depends on what we value as "ordered": the milk, or the cup of coffee. The dangerous "subterfuge" of entropy and negentropy is that they then seem to provide an objective "grounding" for such values and seem to accord with a naturalisation of values. It was precisely on such a point that Nietzsche remained suspicious of science and considered that it was still in need of philosophical critique: science continues to be inflected with many metaphysical notions.[74] These include the tendency to anthropomorphise—to see human traits and interests that we have "projected" into the world, and to imagine that they are objectively intrinsic to it. Following the old "highest values," we still tend to see the true, the good, and the beautiful in the world—they unconsciously filter our impressions and understanding. Writing of the cosmos, Nietzsche insists that "[n]one of our aesthetic and moral judgments apply to it."[75] The recent move away from ascriptions of order and disorder in thermodynamics can be seen in this Nietzschean light as a welcome move in breaking with anthropomorphism and aesthetic and ethical images of the universe. It can be understood as heading in the direction of a fuller "de-deification" of nature and preparing the way for a more intellectually honest appraisal of nature, on the basis of which a naturalisation of values, "beyond good and evil," might proceed.

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73 Frank L. Lambert, "Disorder - A Cracked Crutch for Supporting Entropy Discussions," *Journal of Chemical Education* 79, no. 2 (Feb 2002), 187. See also Evguenii I. Kozliak and Frank L. Lambert, " "Order-to-Disorder" for Entropy Change? Consider the Numbers!" *The Chemical Educator* 10 (2005), 24-25.

74 Nietzsche describes these metaphysical aspects still present in science as making it the latest avatar of the ascetic ideal in GM III.

75 GS 109.

5. Revaluing Values

Having critically questioned the way metaphysical values have been ascribed in thermodynamic concepts, I would like to turn finally to the question of revaluing values, of naturalising values on the basis of a de-deified nature. We may, I believe, take Nietzsche's attempts in this direction as provisional—as he was self-consciously aware, he was a product of his own time, and could only pave the way for such a revaluation. It is possible that some of the points raised above, such as the dissociation of entropy and disorder, already point towards a nature more de-deified than Nietzsche was able to think. Nevertheless, we can add grist to the mill of the argument that entropy should be affirmed if we consider what Nietzsche believed it *is* about existence that needs to be affirmed, and see entropy as expressing many of the same aspects.

While they are often used as short-hand terms for each other and run together in the literature and popular discussion, entropy (as we have noted) is the name for energy in a dissipated, spread-out, or "disordered" state, and the Second Law concerns the tendency of entropy to *increase*.[76] As we have seen, Nietzsche's criticisms revolve around the Second Law implying a final state. If, however, we take entropy on its own terms, there is abundant reason to associate it with notions that Nietzsche sought to positively revalue and affirm in his philosophy, in contrast to the Christian-Platonic tendency to devalue them: entropy may be understood as a principle closely associated with destruction, chaos, disorder, the irrational, the Dionysian, transformation, and becoming. Let me briefly outline a number of these associations.

First, we can see such associations in Nietzsche's cosmology. We can find the basis for the cosmology he prefers and affirms in his lectures on the Pre-Platonic philosophers from 1872–76.[77] This cosmology is essentially Heraclitus's, which Nietzsche interprets as a superior alternative to the image of existence presented by Anaximander ("the first pessimist."[78]) For Anaximander, the cosmos is characterised by Becoming and Passing Away: the fact of Becoming is presented as constituting an "injustice," which must be atoned for by Passing Away. (We can see here intimations of the Christian view of existence as guilty, and in need of redemption, and of Platonic metaphysics which devalues Becoming.) It is in fact Anaximander's condemnation of existence we encountered above, put by Goethe into Mephistopheles's mouth: "everything that comes into being,

76 Clausius's statement of the Second Law in the same paper in which he coined the term entropy is: "*The entropy of the universe tends to a maximum*" ("On Several Convenient Forms," 365), and in a widely used contemporary thermodynamics textbook we find one statement of this law as simply "Entropy tends to increase." (Daniel V. Schroeder, *An Introduction to Thermal Physics* (Oxford: Oxford University Press, 2021), 76).

77 Friedrich Nietzsche, *The Pre-Platonic Philosophers*, trans. and ed. Greg Whitlock (Urbana and Chicago: University of Illinois Press, 2006).

78 Nietzsche, *The Pre-Platonic Philosophers*, 37.

deserves to perish." For Nietzsche, Heraclitus's cosmology is superior because existence is portrayed as "innocent," with both Becoming and Passing Away presented as part of the same essential process of creation and destruction, likened to the play of a child, building sand castles at the beach and then smashing them for sheer pleasure.[79]

For Heraclitus, the process of Becoming and Passing Away is eternal, and the cosmos has no end which will not then spontaneously produce another beginning. This is indicated in several of the Fragments:

> 30. This ordered universe (cosmos), which is the same for all, was not created by any one of the gods or of mankind, but it was ever and is and shall be ever-living Fire, kindled in measure and quenched in measure.[80]
>
> 103. Beginning and end are general in the circumference of the circle.[81]

Among many other indications, the following unpublished note from May–June 1888 clearly demonstrates that Nietzsche was still informed by these Pre-Platonic notions while developing his late thoughts on cosmology using the notions of will to power and eternal return:

> *The new world-conception.*— The world exists; it is not something that becomes, not something that passes away. Or rather: it becomes, it passes away, but it has never begun to become and never ceased from passing away—it maintains itself in both.[82]

Thought in terms of Anaximander's metaphysics, entropy may be understood as the Passing Away, and heat death can be understood as the ultimate "recompense" for coming into being in the first place. This resonates with Hartmann's pessimistic argument for an end state to the universe, which he hopes will not begin again. Nietzsche, however, preferred the Heraclitean view because it presents Becoming as innocent.

Like the idea of Passing Away, entropy might be understood as a principle of destruction. Now, destruction is a feature of existence that Nietzsche sought to revalue, believing

79 Nietzsche writes: "The Passing Away (ψθορα) is in no way a punishment. Thus Heraclitus presents a cosmodicy over against his great predecessor, the teacher of the injustice of the world." *Pre-Platonic Philosophers*, 63. For Nietzsche's riff on Heraclitus's theme of children's play, see BT 114.

80 In Kathleen Freeman (ed.), *Ancilla to the Presocratic Philosophers* (Cambridge, Mass.: Harvard University Press, 1948), 40.

81 *Ancilla to the Presocratic Philosophers*, 46.

82 WP 1066.

that it needs to be affirmed as necessary, and as having a desirable (as well as a nihilistic) manifestation:

> The desire for destruction, for change and for becoming can be the expression of an overflowing energy pregnant with the future (my term for this is, as is known, "Dionysian").[83]

Nietzsche even presents himself and his work (in "thermal" terms!) as self-destructive and world-destructive:

> Yes, I know whence I have sprung!
> Insatiable as a flame
> I burn and consume myself!
> Whatever I seize hold on becomes light,
> whatever I leave, ashes:
> certainly I am a flame.[84]

Destruction is a necessary part of the process of change, and in a similar way entropy may be understood as an essential aspect of becoming. Entropy is a principle of process, change, and transformation, and thus the becoming that Nietzsche sought to affirm over the nihilism of static Being.[85] This association of entropy with transformation is strikingly indicated by Clausius's explanation of his coining of the term:

> [A]s I hold it to be better to borrow terms for important magnitudes from the ancient languages, so that they may be adopted unchanged in all modern languages, I propose to call the magnitude S the entropy of the body, from the Greek word τροπή, transformation.[86]

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83 GS 370.

84 R.J. Hollingdale's translation of the poem "*Ecce Homo*" in *The Gay Science*, put (back) into verse form here following Nietzsche's German original. Hollingdale, "Introduction," in *Dithyrambs of Dionysus*, trans. R. J. Hollingdale (London: Anvil Press, 1984), 10.

85 Gilles Deleuze emphasises this: "What nihilism condemns and tries to deny is not so much Being, for we have known for some time that Being resembles Nothingness like a brother. It is, rather, multiplicity; it is, rather, becoming. Nihilism considers becoming as something that *must* atone and must be reabsorbed into Being, and the multiple as something unjust that must be judged and reabsorbed into the One. Becoming and multiplicity are guilty - such is the first and the last word of nihilism." *Pure Immanence*, trans. Anne Boyman (New York: Zone Books, 2001), 84.

86 Clausius, *The Mechanical Theory of Heat*, 357.

From this point of view, to denounce entropy as the "curse" of the universe would be the very gesture of nihilism, negating the value of immanent existence because of its character as change, transformation, and becoming.

Conclusion

As we have known since Popper, even our best science should always be considered falsifiable and revisable. Moreover, as we have known since Hume, values (*oughts*) don't simply follow from facts (*is*'s). We "naturalise values," we stay true to the meaning of the earth, by following the best science of our times, recognising that we are *interpreting* not only the values on which we base the supposed facts, but the facts themselves. This is no excuse for denying the most plausible interpretations, and if, as seems to be the case today, we are largely constrained to admit the likelihood (if not certainty) of entropy, the Second Law, and their consequences, then we should certainly be able to affirm them. In the current scientific context, naturalism and life-affirmation decide in favour of affirming, rather than denying or decrying, entropy.

Philosophies of technology seem to have been particularly tempted by the naturalisation of values which valorises negentropy and demonises entropy. This is perhaps understandable insofar as the laws of thermodynamics emerged from the close study of the technology of the steam engine (rather than from initial observations of nature). If we care about naturalisation with an existential dimension, however, in philosophy of technology as in all philosophy we should make an effort to let go of the "naturalisation" of evil as entropy, which is an importation from the theological tradition. Instead, we should embrace the spirit of Nietzsche's philosophy, rather than the letter of Nietzsche's text, in *affirming* entropy. In doing so, it is helpful to emphasise those aspects of entropy which resonate with Nietzsche's ontology of becoming. We should affirm entropy, because it is becoming itself, life itself, and the consequences of the Second Law should be affirmed just as death must be tragically affirmed as a part of life. We will advance a long way in banishing the shadows of the dead God when we stop imagining demons in the very fabric of nature and learn how to live with it rather than imagining it as an adversary. And this, in a tragic spirit, involves affirming things that are difficult, things we are tempted to deny. It is high time that, in this spirit, we learn to affirm entropy.

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