

Roundtable:

The future of culture in more-than-human worlds of being

The physics of meaning: More than inhuman?

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The ambition of this paper is to say that if “cultural science” accepts the need to rethink culture along scientific rather than just critical lines, then at the same time physics must rethink its own commitment to “culture-free” methodology. That has only yielded what we might call “meaningless universe theory,” without addressing ways that physics as a discourse is strongly marked by culture, with the usual signs of gender, race, and hegemony present in its methods. It needs to take responsibility for applications of its discoveries that enter the cultural sphere only to threaten its total annihilation. An alternative to meaninglessness might be to take more seriously the marginalized and derided cultures of everyday thinking, as is attempted by Bogna Konior, and for physics-as-a-discipline to join the effort to reform science. If self-criticism is good for the cultural goose, then it’s good for the scientific gander; and a “cultural science” should say so. Since physics is the most scientific and least cultural of the sciences, this paper uses it as a limit case of knowledge realism. I argue that a science of culture requires reform of the ideology and applications of science as well as new models of culture.



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Struggles

In order to stake a reality claim over 'life, the universe, and everything' (Adams, 1984), physics has striven to be 'culture-free' (Weinberg, 1998). But no sooner had the general theory of relativity been discovered than it was weaponised and used against enemies, bringing physics fully into line with the general culture of modernity, where *struggle* took over from divine revelation as the arbiter of truth. Shaking off 'everyday thinking' (Einstein, 1936) led physics straight to the formula for nuclear holocaust.

For John Milton, the modern struggle was between republican Parliament and papist absolutism. In his much-cited pamphlet *Areopagitica* (1644), Milton describes how he 'visited the famous Galileo, grown old, a prisoner to the Inquisition, for thinking in astronomy otherwise than the Franciscan and Dominican licensers thought'. These 'prelates' are the 'race of deceivers who took the virgin Truth, hewed her lovely form into a thousand pieces, and scattered them to the four winds'. Finding and reassembling the dismembered parts was the work of succeeding generations: for Marx, class struggle; for Darwin, evolutionary struggle; for Freud, the struggle with the self; in the novel, the individual struggle with circumstances.

All these struggles were imagined as existential, not necessarily expecting to be resolved one way or the other, but permeating the personal, social, natural, and even cosmological universe. Everyone becomes a combatant. Politics was reconstituted as a struggle between 'we' and 'they' communities, each entity defining itself in opposition to its most serious rival, be that a city, nation, empire, religion, or ideology. The abstract formula of 'we/they' polarity was an 'empty signifier', available for any object or value to be inserted into the 'we' position, identifiable by *not being* an equally arbitrary 'they' opponent. If struggle is the general motive force of life, then polarisation between tradition (culture) and modernity (technology) is the most efficient driver of 'progress' (Latour, 1993: 37-9). Under that banner, 'we' status can be claimed as a fundamental 'natural law', as in the US Constitution and Bill of Rights, for example (Desmond, 1953).

What is needed to weld together a new 'we' community (Anderson, 2016) is an appropriate 'they' with which to conduct a necessary and possibly endless struggle. Thus, colonialism constructed a racist struggle between 'advanced' and 'primitive' societies (Graeber & Wengrow, 2021). Orientalism opposed West and East. Industrialisation not only inaugurated class antagonism in each country, but also opposing world-systems. That's the plot of Orwell's *Nineteen Eighty-Four*, of course.

Science – one of the great textual systems of modernity, along with journalism and the novel – was recruited to the modern cause, claiming the right to 'dominion' over the cosmos, the Earth-system, and unenlightened cultures at large:

Since every Renaissance art aimed for a dominion or conquest, it was completely appropriate that science should leave its previously contemplative role and focus upon the conquest of nature. (Grudin, 2023)

In the name of this modern project, Europeans claimed the right to dominion over the world and with that over 'irrational' humans however defined, such as colonised people, women, children, the deviant, dissident, or daft. These needed to be rounded up into appropriate institutions (where even the domestic home could become the concentration camp), while free-spirited Reason could range free to appropriate the world. Trying to imagine how to live within such polarities gave rise to another polarity: Rationalism vs. Romanticism. With Goethe, Romanticism internalised the concept of

existential struggle, where the displaced and finite individual became a wanderer, whose destination was not victory but death.

Even music turned from tonal harmony to chromatic struggle with Richard Wagner, whose works so often dramatise the struggle between human and supernatural, love and power, creation and destruction, tending all the way to *Götterdämmerung* – the self-destruction of entire meaning systems (Ross, 2020).

In the process, rationalism and romanticism were pushed further apart, each becoming the other's opposite, such that 'science' was fortified for the realists, while 'culture' was left to wander around outside as the irrational residue of premodern, magical, and delusional thinking (Ball, 2023), especially *popular* culture, where modernity found its dark-side delusions more than welcome.

'And yet it moves'

With Galileo, physics 'definitively' started (Bumstead, 1921: 289). However, the Catholic Church already claimed the universe as its own patch (that's what 'Catholic' means). It imprisoned Galileo for thinking otherwise. But with his defiant declaration: '*Eppur si muove*' ('And yet it moves'),¹ the real became a captive of physics. The Earth moved for everyone.

In the process, physicists sought to rid themselves of metaphysical spectres, aiming to become 'culture-free':

Even though a scientific theory is in a sense a social consensus, it is unlike any other sort of consensus in that it is culture-free and permanent (Weinberg, 1998: 161-2).

Despite the importance of doubt to scientific method, there was no doubting science. Even though *relativity* is its most famous achievement, physics routinely expresses ritualised derision for *relativism* and its postmodern siblings: social constructivism, historicism, and deconstruction. These introduced doubt into modern thinking, including scientific self-description. But the sciences did not treat these doubts in good faith. Instead, they chorused ridicule for those cultural rascals, who were about as welcome to the scholarly table as Banquo's ghost (Sokal and Bricmont, 1998).

However, in a 1936 essay, Einstein himself discusses the difference between what he calls 'the man of science' and the philosopher. Einstein argues that the 'physicist cannot simply surrender to the philosopher the critical contemplation of the theoretical foundations', owing to the 'waves of doubt' that, at the time, had caused 'the very foundations of physics itself' to become as 'problematic as they are now'. For Einstein, the physicist 'cannot proceed without considering critically a much more difficult problem, the problem of analysing the nature of everyday thinking' (2005: 22-3).

But Einstein lost that struggle. Because physics as a discipline strove to become 'culture-free', it remained ignorant of the extent to which 'the man of science' was not just a grammatical neuter, but a cultural type – not only a man, but also typically a white, first-world normie, filtered by an institutional education system that in turn was state-directed towards the economic and strategic exploitation of the laws of physics. The 'nature of everyday thinking' remained beyond the reach of

¹ Galileo was judged 'guilty of having wanted to "impose need" on "omnipotent God" by laying on Him the burden of the creation of a moving Earth': <https://brunelleschi.imss.fi.it/itineraries/itinerary/thetrial.html> [last access: 09/05/2024]. His 'severe and pernicious error', professing heliocentrism rather than geocentrism, was declared heretical and he was punished by house arrest for the rest of his life. 'And yet it moves' refers to the motion of the Earth. Did Galileo ever say it? See: <https://www.scientificamerican.com/blog/observations/did-galileo-truly-say-and-yet-it-moves-a-modern-detective-story/> [last access: 09/05/2024].

physics, which concentrated on dominating the biosphere (life), geosphere (planet), and everything else in 'this amazing and expanding universe' (as Eric Idle's wonderful 'Galaxy Song' has it).²

What physicists know (Sun & Latora, 2020) was placed in direct opposition to what 'everyday thinking' thinks. Physics belongs to 'armed' or specialist knowledge, institutionally organised for *inter*-cultural competition, conflict, and conquest. 'Everyday thinking' is unorganised 'connective' or 'common knowledge', for *intra*-cultural recognition, community, and identity (Hartley, 2018).

Götterdämmerung

Nevertheless, not only must everyday experience obey the laws of physics, but the laws of physics must pass the test of everyday experience. Physicist Charles Critchfield introduced post-war readers to particle physics, reporting that: 'by using modern instruments to delve into the world of very small collision distances, new and astonishing phenomena are being discovered' (1951: 42-3). He sought to link the laws of physics to everyday experience: 'An inviolate requirement on any branch of modern physics is this: that when its rules are applied to objects of our everyday experience, the rules become the everyday rules' (1951: 42).

Critchfield certainly knew how the 'astonishing phenomena' of the world of 'very small collision distances' could be 'applied' to the everyday experience of unsuspecting citizens. He had been a team-leader on the Manhattan Project, responsible for the 'urchin' internal neutron initiator.³ To detonate an atom bomb, a conventional explosion compressed a ball of beryllium and polonium. Critchfield's team, working against the clock, found that this compressed mixture released sufficient neutrons to trigger a chain reaction of explosive force in the plutonium in which the 'urchin' was buried.⁴ It was one of the last components made before the Trinity test of 1945, which inaugurated the 'nuclear age'. Three weeks later this application of the laws of physics was dropped on Hiroshima, leading to 214,000 immediate deaths there and in Nagasaki, and to lifelong aftereffects for the 'Hibakusha' survivors.⁵

As cinemagoers now know, Robert Oppenheimer, head of the Manhattan Project, greeted the dawn of that age not with physics but with metaphysics: 'Now I am become Death, the destroyer of worlds.'⁶ Christopher Nolan's 2023 blockbuster biopic was not released in Japan until eight months after the US premiere. It was not so well received by the Hibakusha as it had been on the US press and publicity circuit. The survivors' organisation waited in vain for the movie to show the bombing

² 'The Galaxy Song' (1983). Sung by Eric Idle: <https://www.youtube.com/watch?v=buqtdpuZxvk> [last access: 09/05/2024]. Stephen Hawking's rendition (2015): <https://www.youtube.com/watch?v=XfcC6FYyL4U> [last access: 09/05/2024]. Lyrics at: <https://www.lyrics.com/lyric/3504724/Eric+Idle/The+Galaxy+Song> [last access: 09/05/2024]

³ See an informative interview with Critchley by Richard Rhodes: <https://ahf.nuclearmuseum.org/voices/oral-histories/charles-critchfields-interview/> [last access: 09/05/2024].

⁴ For an explanation, see: <https://www.osti.gov/opennet/manhattan-project-history/Science/BombDesign/initiators.html> [last access: 09/05/2024]; and: https://en.wikipedia.org/wiki/Modulated_neutron_initiator#Urchin [last access: 09/05/2024]

⁵ See: https://www.icanw.org/hiroshima_and_nagasaki_bombings [last access: 09/05/2024].

⁶ Quoted and discussed on the US Government's Los Alamos website, under the heading of 'Plutonium and Poetry: Where Trinity and Oppenheimer's reading habits met': <https://discover.lanl.gov/news/0714-oppenheimer-literature/> (2012) [last access: 09/05/2024].

scene. A former mayor of Hiroshima, also a survivor, told AP that 'The film was made in a way to validate the conclusion that the atomic bomb was used to save the lives of Americans.'⁷

Instead of depicting the bomb's effect on a quarter of a million 'everyday people', *Oppenheimer* focuses on its effect on one physicist. It includes a scene where Oppenheimer confides in Einstein (for it is he):

"When I came to you with those calculations," Oppenheimer tells Einstein, "we thought we might start a chain reaction that might destroy the entire world."

"What of it?" Einstein asks.

"I believe we did," Oppenheimer says.⁸

Perhaps it is already too late. In 2021, ahead of the COP26 Climate Conference in Glasgow, physicist Brian Cox told *The Guardian*:

If you accept that meaning is something that emerges from sufficiently complex biological machines, then the only place those machines might exist is here; then it's correct to say that if this planet weren't here, we'd live in a meaningless galaxy.⁹

Now, when angry, anti-science populism fills the benches of elected legislatures and the heads of heads of state, science is being outrun by fiction. Physics, the 'Big Science' enemy of populism, can only defend itself by turning populist. 'Culture-free' scientific method gives way to showbiz. Physicist Brian Cox for one has seen the light. His latest extravaganza is a *Symphonic Odyssey* (2023-24).¹⁰ Following Stanley Kubrick's 2001: *A Space Odyssey* (1968), he serves up the marvels of the universe with lashings of colour and sound, to warn humanity that because of its folly, eternal meaninglessness is nigh. In the Sydney Opera House, he repeated his warning to world leaders:

'We've made the only island of meaning in an ocean of 400 billion suns. And therefore, if we destroy this, then we may eliminate meaning in a galaxy of 400 billion suns. Potentially forever. Discuss'.¹¹

It was a mic drop moment.

⁷ Aaron Boorstein in the *Smithsonian Magazine*, 5 April, 2024: <https://www.smithsonianmag.com/smart-news/oppenheimer-premieres-in-japan-eight-months-after-worldwide-release-180984094/> [last access: 09/05/2024].

⁸ Quoted in: <https://www.vulture.com/article/oppenheimer-ending-explained-christopher-nolan.html>. In fact, the physicist Charles Critchfield did not believe that the physicists were as important as Oppenheimer made out. He told an interviewer: 'Well, look, the physicists didn't do the major part of the bomb. ... They're the ones who really believed ... But the hard problem was in the explosives and the chemistry, the metallurgy.' (<https://ahf.nuclearmuseum.org/voices/oral-histories/charles-critchfields-interview/>). Unlike physicists, chemical engineers have not proven so amenable to pop-mythologisation.

⁹ Source: <https://www.theguardian.com/science/2021/oct/19/earths-demise-could-rid-galaxy-of-meaning-warns-brian-cox-ahead-of-cop26> [last access: 09/05/2024].

¹⁰ See the venues here: <https://briancoxlive.co.uk/#tour> [last access: 09/05/2024].

¹¹ *A Symphonic Odyssey with Professor Brian Cox* (2024): <https://iview.abc.net.au/show/symphonic-odyssey-with-professor-brian-cox> [last access: 09/05/2024].

‘More than human’

Setting physics and philosophy to music has a long history (Youmans, 2005). But after 2001, Richard Strauss’s Nietzschean tone poem *Also Sprach Zarathustra* (1896) is irrevocably associated with outer space. Nietzsche himself had opened his philosophical fiction *Also Sprach Zarathustra* (1883) with a mountain-dawn sunrise, in a passage that Strauss quoted in his own score (Fink, 2022). Knowing it would be expected by movie-literate audiences, Cox included Strauss’s famous musical sunrise in his own Symphonic Odyssey.¹²

It is likely that neither Strauss nor Cox meant to evoke Nietzsche’s *Übermensch* ideology. But inevitably, they were playing with fire. The fantasy of the Superman is alive and kicking, more popular than science or philosophy, motivating tech billionaires, populist politicians, and popular-culture fantasy franchises.

In his *History of Western Philosophy*, Bertrand Russell wrote of Nietzsche:

I dislike Nietzsche because he likes the contemplation of pain, because he erects conceit into a duty, because the men he most admires are conquerors, whose glory is cleverness in causing men to die. ... Nietzsche despises universal love; I feel it the motive power to all that I desire as regards the world. His followers have had their innings, but we may hope that it is coming rapidly to an end. (Russell, 1961: 739).

Universal love? Vain hope! Perhaps what is ‘coming rapidly to an end’ is humanity not ‘cleverness in causing men to die’. What would it take to imagine a post-Nietzschean ‘more than human culture’, using the ‘motive power’ of love? My own response (Hartley, 2025 in press) is to channel Russell, who prefers ‘universal love’. He is not the only one. Karen Barad (2007; 2012) has queered quantum physics enough to be able to suggest that ‘touching’ – ‘response-ability’ – is what makes matter. Humberto Maturana (1980; 1996; 2009) has inaugurated a ‘biology of love’.

Humans use language in a ‘more than human’ way: to apprehend and act on the world, and thence to make themselves. Judith Butler has investigated how what she calls ‘excitable speech’ is caught in a bind: ‘we exercise the force of language even as we seek to counter its force, caught up in a bind that no act of censorship can undo’ (Butler, 1997: 1). Butler asks: ‘Is our vulnerability to language a consequence of our being constituted within its terms?’ (1997: 1-2). The *constitutional* nature of language means that humans are ‘linguistic beings’, who ‘require language in order to be’. Language itself exercises a ‘more than human’ prior power over its users. Following Butler, physicists might call language the ‘excitable medium’ (Zykov, 2008), by means of which humans act on a field they call reality (Jepsen, 2013).

But they don’t have that field to themselves. Those interested in the ‘more than human’ usually turn to the biosciences, increasingly backed up by the communication sciences. They find communication everywhere, right down to the level of the cell and single-cell lifeforms, giving rise to the idea that ‘life’ and ‘sign’ are one and the same (Kull & Emmeche, 2011). Donna Haraway has been widely influential in extending cultures to both science (1988) and animals (2016). Other supposedly human attributes, such as ritual, have been found to be ‘a universal aspect of vertebrate life’:

¹² Unusually, the orchestra played the whole work, as well as pieces from Sibelius, Westlake, and Mahler. See: <https://www.sydney-symphony.com/uploads/images/Program-Books/2023/2023-Professor-Brian-Cox-Symphonic-Horizons-Program-Book.pdf>. [last access: 09/05/2024]

Ethologists recognize that animals (at least social species) also have culture—socially learned and transmitted behavioral repertoires that are not genetically inherited. (Hartigan, 2022)

Journalists too report numerous scientific accounts of culture, for example among primates, cetaceans, birds, and bees. One such item summarises this trend, even as it reserves humanity's special status as 'different in nature' from animals:

Although some scientists avoid ascribing "culture" or "language" to animals because their connections and communication are different in nature from human beings, a growing body of research suggests culture ... is prevalent across many species in the animal kingdom. (Hlavinka, 2023/4).

'Think about the inhuman'

Physics is not forgotten, because communication extends into the world of 'inert' matter via computational technologies, machine learning, and Artificial Intelligence. Benjamin Bratton argues that 'the emergence of planetary-scale computation thus appears as both a geological and geophilosophical fact'. He ascribes scientific ideas not to humans but to computation. Climate change is 'a conceptual accomplishment of planetary scale computation' (Bratton, 2021).

Bratton has assembled a global team called *Antikythera* to think about 'planetary sapience'. One of the most daring thinkers on the Antikythera project is Bogna Konior, who extends the idea of 'sapience' from human minds to machines and back again:

Although the term "Synthetic Minds" immediately evokes artificial intelligence, we should not overlook the fact that all minds may be a priori and inherently synthetic. This is ... due to the intimate relation between cognition and the so-called 'artifice' through which it operates, including language itself.¹³

In a long interview, Konior (2022) reappraises the very culture from which both 'different in nature' humanity and 'culture-free' physics exempt themselves, looking for inspiration on how 'technology and theology make us think about the inhuman, how we conceptualize causality, the outside, free will, and the long game of cosmic history.' Konior considers:

the idea that Catholic female stigmatics and mystics are early thinkers of the internet, of "virtual" sex, of AI love and machine personhood (via the figure of angels), of xenowombs and asexual reproduction (via the idea of immaculate conception), and so on. (2022)

She learns from versions of the human that have longest experience of being subjects who are turned into objects:

I am compelled by the genre of cyberfeminism or posthumanist feminism, where we begin from the stance that women as objects or simulations could enter into the age of the machine from a more cunning, ambivalent position than the human 'master subjects.' (Konior, 2022)

¹³ Abstract taken from the blog of Medialab-Matadero Madrid: <https://www.medialab-matadero.es/en/news/synthetic-minds-bogna-konior> [last access: 09/05/2024]

With physics as an inhuman science, you can only choose your ending: do you want Oppenheimer's feared 'chain reaction that might destroy the entire world' or a new 'great extinction' (Ritchie, 2022), alongside climate change, rising sea-levels, environmental destruction, and pollution? Such a choice is of course the stuff of science-fiction. Caitlin Cronenberg's film *Humane* (2024) is described in *Variety* as 'a dark-as-midnight domestic thriller about how climate change, totalitarianism, and euthanasia all go together.'¹⁴ It's a horror movie dressed up as a dinner party, and its title is entirely ironic. The more we know, it seems to suggest, the more inhumane we become.

But a more cunning, ambivalent science of culture is out there, hiding in plain sight, among the excluded components of 'everyday thinking'. *Cultural Science Journal* may be well-advised to stand to the side of the Nietzschean sciences as well as science-fiction for the time being, to encourage reform not only of the study of culture but also the practice of science. As we watch a new 'rough beast, its hour come round at last', as it 'slouches towards Armageddon',¹⁵ we need to think about improving the prospects and mechanisms for something all too human: common knowledge and love.

That takes us a long way from Los Alamos, but it still may need to contemplate our extinction, but now as a good idea:

The species as it is will not survive. ... perpetuating intelligence is a worthy goal, though not only in a biological sense, but also through digital memetics, and robotics, and maybe even autonomous infrastructures in the future. I just think these need to be maintained in symbiosis with actual organisms. ... I think we gotta mutate or alter ourselves to survive, whether on a social level or on the actual biological level. (Konior, 2022)

Instead of Strauss's Nietzschean 'Sunrise', perhaps we should close with his *Four Last Songs*. The last of these is 'Im Abendrot' ('At Sunset'), where 'Abend' also means 'a sudden or unexpected failure in a software program, application, or operating system, usually causing it to crash'.¹⁶ Unless 'we' – humanity of all kinds – can contest the default settings of enmity in 'everyday thinking' and scientific practice alike, the only culture that humankind may bequeath to the universe will be its posthumous 'thoughts and prayers' (Willingham, 2018) – and eternal meaninglessness.

References

- Adams, D.** 1984. *Life, the Universe and Everything: Hitchhiker's Guide to the Galaxy* Book 3. Macmillan.
- Anderson, B.** 2016. *Imagined Communities: Reflections on the Origin and Spread of Nationalism*. Revised edition. Verso.

¹⁴ See: <https://variety.com/2024/film/reviews/humane-review-caitlin-cronenberg-1235984447/> [last access: 09/05/2024].

¹⁵ W.B. Yeats's 'Second Coming' (<https://www.poetryfoundation.org/poems/43290/the-second-coming> [last access: 09/05/2024]) has been updated: <https://www.defenseone.com/ideas/2022/01/slouching-towards-armageddon/360953/> [last access: 09/05/2024]. In 'this moment of historic danger', the Atomic Scientists' Doomsday Clock is set at 90 seconds to midnight: <https://thebulletin.org/doomsday-clock/> [last access: 09/05/2024].

¹⁶ Richard Strauss - *Vier letzte Lieder* (Four Last Songs) (1950) IV. 'Im Abendrot' (Joseph von Eichendorff). Jessye Norman, soprano; Gewandhausorchester Leipzig (1982) conducted by Kurt Masur: <https://www.youtube.com/watch?v=envQ-ZqGQu8> [last access: 09/05/2024]. For the 'crash' meaning of Abend, see: <https://www.dictionary.com/browse/abend> [last access: 09/05/2024].

- Ball, P.** 2023. Science as Culture and the Science of Meaning: Conflict tor Consilience? *Marginalia Review of Books*, 23 June. <https://www.marginaliareviewofbooks.com/post/science-as-culture-and-the-science-of-meaning> [last access: 06/05/2024]
- Barad, K.** 2007. *Meeting the Universe Halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press.
- Barad, K.** 2012 On Touching—the Inhuman That Therefore I Am. *Differences*, 23(3): 206-23. <https://doi.org/10.1215/10407391-1892943>
- Bratton, B.** 2018. On Hemispherical Stacks: Notes on Multipolar Geopolitics and Planetary-Scale Computation. *Scribd*. <https://www.scribd.com/document/427991851/> [last access: 06/05/2024]
- Bratton, B.** 2021. Planetary Sapience. *Noēma Magazine*, June 17. <https://www.noemamag.com/planetary-sapience/> [last access: 06/05/2024]
- Bumstead, H.A.** 1921. The history of physics. *The Scientific Monthly*, 12(4), 289-309. <https://www.jstor.org/stable/6605> [last access: 06/05/2024]
- Butler, J.** 1997. *Excitable Speech: A Politics of the Performative*. Routledge.
- Critchfield, C. L.** 1951. Modern Physics. *Journal of the Minnesota Academy of Science*, 19(1), 40-42. <https://digitalcommons.morris.umn.edu/jmas/vol19/iss1/14/> [last access: 06/05/2024]
- Desmond, C.** 1953. Natural Law and the American Constitution. *Fordham Law Review*, 22(3), 235-45. <https://ir.lawnet.fordham.edu/cgi/viewcontent.cgi?article=1424&context=flr>
- Einstein, A.** 1936, republished 2005. Physics and reality. *Daedalus*, 132(4), 22-25. <https://www.jstor.org/stable/20027877> [last access: 06/05/2024]
- Fink, M.** 2022. The story of Strauss' *Also Sprach Zarathustra*. Rhode Island Philharmonic Orchestra and Music School. <https://www.riphil.org/blog/the-story-behind-strauss-also-sprach-zarathustra> [last access: 06/05/2024]
- Graeber, D. and Wengrow, D.** 2021. *The Dawn of Everything: A New History of Humanity*. Allen Lane.
- Grudin, R.** 2023. Humanism – The English Humanists. *Britannica Online*. <https://www.britannica.com/topic/humanism/The-English-humanists> [last access: 06/05/2024]
- Haraway, D.** 1988. Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies*, 14(3), 575-599. <http://www.jstor.org/stable/3178066> [last access: 06/05/2024]
- Haraway, D.** 2016. Tentacular Thinking: Anthropocene, Capitalocene, Chthulucene. *E-Flux Journal* 75. <https://www.e-flux.com/journal/75/67125/tentacular-thinking-anthropocene-capitalocene-chthulucene/> [last access: 06/05/2024]
- Hartigan, J.** 2022. Animal ritual. *Oxford Bibliographies*. <https://www.oxfordbibliographies.com/display/document/obo-9780199766567/obo-9780199766567-0279.xml> [last access: 06/05/2024]
- Hartley, J.** 2025 in press. *Make/Believe: We and They on a Digital Planet*. Bloomsbury.
- Hartley, J.** 2018. What Hope for Open Knowledge? Productive (Armed) vs. Connective (Tribal) Knowledge and Staged Conflict. *Cultural Science Journal*, 10(1). <https://doi.org/10.5334/csci.107>
- Hlavinka, E.** 2023/4. These 5 animals have culture. Here's what they can reveal about our shared evolutionary experience. *Salon*. <https://www.salon.com/2023/11/16/these-5-animals-have-culture-heres-what-they-can-reveal-about-our-shared-evolutionary-experience/> [last access: 06/05/2024]

- Jepsen, K.** 2013. Real talk: Everything is made of fields. *Symmetry Magazine*, U.S. Dept. of Energy. <https://www.symmetrymagazine.org/article/july-2013/real-talk-everything-is-made-of-fields> [last access: 06/05/2024]
- Konior, B.** 2022 The Impersonal Within Us: A conversation with Bogna Konior. Podcast and transcript: *Chaosmotics: Thinking Unbound*: <https://www.chaosmotics.com/en/featured/the-impersonal-within-us> [last access: 06/05/2024]
- Kull, K. and Emmeche, C.** (Eds.) 2011. *Towards a Semiotic Biology: Life is the Action of Signs*. Imperial College Press/World Scientific.
- Latour, B.** 1993. *We Have Never Been Modern*. Harvard University Press.
- Maturana, H. & Varela, F.** 1980. *Autopoiesis and Cognition: The Realization of the Living*. Reidel. https://monoskop.org/images/3/35/Maturana_Humberto_Varela_Francisco_Autopoiesis_and_Cognition_The_Realization_of_the_Living.pdf
- Maturana, H. and Verden-Zöller, G.** 1996. *Biology of Love*. <https://bsahely.com/2018/01/16/biology-of-love-by-humberto-maturana-romesin-and-gerda-verden-zoller/> [last access: 06/05/2024]
- Maturana, H. and Verden-Zöller, G.** 2009. *Origin of Humanness in the Biology of Love*. Imprint Academic.
- Milton, J.** 1644. *Areopagitica*. Project Gutenberg. <https://www.gutenberg.org/cache/epub/608/pg608-images.html> [last access: 06/05/2024]
- Ritchie, H.** 2022. There have been five mass extinctions in Earth's history. *Our World In Data*. <https://ourworldindata.org/mass-extinctions> [last access: 06/05/2024]
- Ross, A.** 2020. *Wagnerism: Art and Politics in the Shadow of Music*. Farrar, Strauss and Giroux.
- Russell, B.** 1961. *History of Western Philosophy, and its Connection with Political and Social Circumstances from the Earliest Times to the Present Day*. Second Edition. George Allen & Unwin (reprint by Routledge).
- Sokal, A. and Bricmont, J.** 1998. *Fashionable Nonsense: Postmodern Intellectuals' Abuse of Science*. Picador.
- Sun, Y. and Latora, V.** 2020. The evolution of knowledge within and across fields in modern physics. *Scientific Reports*, 10, 12097. <https://doi.org/10.1038/s41598-020-68774-w>
- Willingham, A.J.** 2028. How 'thoughts and prayers' went from common condolence to cynical meme. *CNN*. <https://edition.cnn.com/2018/02/20/us/thoughts-and-prayers-florida-school-shooting-trnd/index.html> [last access: 06/05/2024]
- Weinberg, S.** 1998. Physics and History. *Daedalus*, 127(1), 151-164. <https://www.jstor.org/stable/20027480>
- Youmans, C.** 2005. *Richard Strauss's Orchestral Music and the German Intellectual Tradition: The Philosophical Roots of Musical Modernism*. Indiana University Press.
- Zykov, V.** 2008. Excitable Media. *Scholarpedia*, 3(5):1834. http://www.scholarpedia.org/article/Excitable_media [last access: 06/05/2024]

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