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Stuart Kauffman's Metaphysics of the Adjacent Possible: A Critique

Abstract

Stuart Kauffman has, in recent writings, developed a thought-provoking and influential argument for strong emergence. The outcome is his Theory of the Adjacent Possible (TAP). According to TAP, the biosphere constitutes a non-physical domain qualitatively distinct from the physical domain. The biosphere exhibits strongly emergent properties such as agency, meaning, value and creativity that cannot, in principle, be reduced to the physical. In this paper, I argue that TAP includes various (explicit or implicit) metaphysical commitments: commitments to (1) scientific realism, (2) downward causation and teleology, and (3) modal realism. If TAP is to hang together as the kind of robust philosophical thesis it evidently aspires to be, it needs an account – an account that is currently absent – of its metaphysical commitments. It is however unclear how such an account can be developed since various dilemmas present themselves when one explores how subscribers to TAP might do so.

Key words

Stuart Kauffman; adjacent possible; scientific realism; downward causation; teleology; modal realism

Introduction

Stuart Kauffman (notably 2000, 2008, 2016, 2019) has developed a bold and provocative argument for strong emergence or – as he prefers – "radical emergence". The conclusion is his Theory of the Adjacent Possible (TAP). TAP states roughly as follows:

> The biosphere constitutes a non-ergodic domain *qualitatively distinct* from the ergodic physical domain. The biosphere cannot, *in principle*, be reduced to the physical. Higher-order phenomena such as *agency*, *meaning* and *value* are *radically* – i.e. ontologically rather than epistemically – *emergent*. They are the product of a *creativity* inherent to the universe rather than of physical laws and/or deterministic processes.

I will elaborate on TAP throughout this paper. This brief summation nonetheless gives a flavour of its revisionary and potentially powerful content. If the argument for TAP is sound, then the way that many scientists and philosophers of science think about the world is wrong. We need a reformed scientific ontology that is, not only inherently dualistic, but that also contains creativity as a central component.

TAP has not been thoroughly critiqued in the philosophical literature up until now. This is surprising given that, although presented in a scientific context, it is clearly of a philosophical nature. This paper should therefore make a novel contribution to the literature. It will be of particular interest to those working in complexity theory and/or origins of life studies since these are, not only Kauffman's areas of expertise, but also the areas where TAP potentially has the most import.

Philosophers are sometimes quick to dismiss scientist's forays into philosophical territory. I think that this is often a mistake. Given the wide influence prominent scientists' philosophical theses often have (think Richard Dawkins' 2006 *The God Delusion*) and, given the ideal of interdisciplinarity many of us aspire to, we – as philosophers – should pay careful attention to arguments like TAP. We should not assume that scientists are philosophically inept. Although my critique of Kaufmann's argument will be mostly negative, my hope is that it will nonetheless prove thought-provoking and potentially lead to fruitful interdisciplinary engagement.

Note however that my aim here is not to develop a positive way forward for TAP. I suspect that this cannot be done given the way the theory is currently formulated. As we will see, TAP faces significant obstacles that seem insurmountable without reworking it into something dramatically different. The upshot is that we can then channel our philosophical and scientific

energies in new and potentially more productive directions regarding topics related to emergence, creativity and the relationship between physics and biology.

In section 1 of this paper, I outline the argument for TAP in some detail.

In section 2, I discuss three key but often tacit commitments that follow from TAP: (1) scientific realism, (2) downward causation and teleology, and (3) modal realism. I will argue that, even while Kauffman does not seem to recognise as much, these are *metaphysical* commitments. Further, while commitment 1 is fairly easily incorporable into TAP, commitments 2 and 3 introduce dilemmic consequences. Some of TAP's implicit metaphysical commitments are not compatible with its explicit claims, and the theory therefore does not hang together as a *robust* – i.e. logically complete and self-consistent – philosophical thesis.

If TAP is to be philosophically robust – as Kaufmann surely intends it to be – he (and/or followers of his view) need undertake the following two tasks:

1. Make TAP's metaphysical commitments explicit. In other words, recognise and express TAP's implicit metaphysical commitments.
2. Account for how TAP is supposed to be compatible with these commitments. A view must, I take it, be logically consistent with its own (explicit or implicit) commitments (see also van der Merwe 2021).

TAP cannot, on pain of incompleteness and self-inconsistency, hold to its three commitments listed above, but fail to account for them; that is, fail to recognise them, and then explain how they should be logically incorporated into TAP. It these commitments are at odds with the tenets of TAP, then the problem is all the worse. TAP would then be logically incomplete and self-inconsistent; it would not be philosophically robust.[1]

In the conclusion, I briefly sum up what has preceded and suggest some possible ways forward in light thereof.

1. TAP: Kauffman's argument for radical emergence

Kauffman's TAP argument can be syllogised as follows:

[1] One might well find metaphysical commitments being tacitly expressed in many (if not all) scientific theories (thank you to an anonymous reviewer for suggesting as much). As with TAP, such theories will need to express and account for their metaphysical commitments if they aim to be philosophically robust.

P1: The universe consists of two distinct domains: the physical domain and the non-physical biosphere.

P2: The biosphere exhibits properties – notably functionality, agency, meaning, value and creativity – not explainable by or reducible to the physical domain.

C: Therefore, reductionism fails, and functionality, agency, meaning, value and creativity are radically emergent.

In this section, I will discuss each of these three steps in the TAP argument in turn. Before doing so, it is important to note the meanings of certain key Kauffmanian terms that may be unfamiliar:

- "Becoming": coming into existence, particularly related to the unfolding of the biosphere and the evolution of new entities and structures therein.
- "Adjacent possible": a kind of possibility space into which the biosphere evolves; it contains the indefinite number of possible things that can become actual given the current state of the universe.
- "Enablement": a kind of facilitation of being or an engendering of the circumstances that allow for what is possible to become actual (not to be confused with causation).
- "Kantian whole": a complex system that exhibits agency, and in which the parts exist for and by means of the whole.
- "Mattering": used in an ontological sense to denote the existence of value.

1.1. P1: Physical/biosphere ontological dualism

According to Kauffman, "the universe has made all the possible types of stable atoms": the bosons and fermions that make up the list of known elements (2019, 2). The universe has however made only a "tiny fraction" of "all possible complex things" (Kauffman 2019, 3), e.g. proteins, organisms, economic markets and computer software systems. The world therefore consists of two distinct domains: the physical domain composed of *ergodic* systems and the non-physical domain composed of *non-ergodic* systems, where an ergodic system is a system that "visits all its possible states over some 'reasonable' time period", while a non-ergodic system is a systems that "does not visit all its possible states" (Kauffman 2019, 4; see also 2000 ch. 7, 2016 chs. 2 and 3).

Further, when modelling some system, says Kauffman, physicists always work with a prestated phase space in which that system obeys deterministic laws. The evolution of the system is logically entailed in the initial conditions and laws, and is therefore, in principle, perfectly predictable. In biology however, there is no prestatable phase space and there are no entailing laws; "ever-new functions constitute the ever-changing phase space of biological evolution" (Kauffman 2016, 70; see also Kauffman 2000, 2008 ch. 10; Longo et al. 2012; Kauffman and Gare 2015). The units of study in biology are changing their states and behaviours in response to contingent factors (notably teleological factors) that are not describable in the language of physics. Laplace's demon, knowing the positions and momenta of all the particles in the universe, could never calculate the emergence of biological entities, properties, states or functions (Kauffman 2016, 102-103, 2019, 11-12).

For Kauffman, the above suggests that his physical/biosphere dichotomy is not the result of contextual conveniences in our modelling practices. It is neither epistemic, nor quantitative. Instead, it is a qualitative ontological distinction our models respond to (Kauffman and Clayton 2006; Kauffman 2008 ch. 2). Therefore, P1: the universe consists of two distinct domains: the physical domain and the non-physical biosphere.

1.2. P2: The radical emergence of the biosphere

According to Kauffman, biological entities like hearts and kidneys exist "*by virtue* of the functional roles these systems and subsystems play in abetting the survival and further evolution of the organisms of which they are parts" (Kauffman 2019, 10 original emphasis; see also 2008 ch. 2). The heart pumps blood to sustain the organism; it is a part that exists "for and by means of the whole". Kauffman also uses the example of the fish's swim bladder (evolved from ancestral lungs in lungfish). "With the swim bladder's emergence, a new function came to exist in the biosphere" (Kauffman 2019, 116; see also Kauffman 2008 ch. 10). Now, goes the argument, a bacterium can adapt to live in such a swim bladder. However, natural selection did not cause[2] or act on the swim bladder to specifically create a niche for the bacterium. The niche did not exist as a possibility before the swim bladder evolved (it is a Darwinian preadaptation). The swim bladder does not cause, but rather "enables" the bacterium's adaptation (Kauffman and Gare 2015, 239-240; Kauffman 2016, 72-74). This leads Kauffman to conclude that the biosphere is *creating* its own future pathways of *becoming*.

[2] Kauffman does not think that there is any formal sense of causation in biology (see Longo et al. 2012).

Enablement is a kind of "making possible" or "niche creation" (see Longo et al. 2012 for detail). There is, says Kauffman, however no conceivable way to predict such niche creation. One could never formally model all possible niches that the biosphere could create. We cannot know what is in the relevant sample space; we cannot – even in principle – prestate the "becoming of the biosphere".[3] The biosphere creates possibility spaces into which it becomes, and it creates possible entities that actualise during the course of evolution. The biosphere thus transforms the universe in a way that is, according to Kauffman, completely unexplainable on a physicalist (or Newtonian, reductionist or mechanistic) worldview. The biosphere, he says, "explodes" in diversity, in complexity. It "is 'sucked into' the very Adjacent Possible opportunities it itself creates" (Kauffman 2019, 129; see also Longo et al. 2012; Kauffman and Gare 2015; Kauffman 2016). For Kauffman, we can consequently conclude that creativity is part of the universe's fundamental constitution.

Moreover, organisms that have functional parts are what Kauffman calls "functional wholes" or "Kantian wholes": complex systems that have sustaining subsystems. Examples include cells, trees, human beings and even whole ecosystems. Kantian wholes are "agents" or "autopoietic systems" that "build themselves" and seize opportunities in "adjacent possible niches" (Kauffman 2000 ch. 2, 2016 ch. 4; see also Longo et al. 2012). Although Kantian wholes have physical energy and particles as input, they are not themselves physical. They are "based on physics, but beyond physics" (Kauffman 2019, 127; see also Boogerd et al. 2005). The agenticity of Kantian wholes further actualises meaning and value in the universe (Kauffman 2019, 12). Kauffmann asks us to "consider a bacterium swimming up a glucose gradient. The sugar matters to the bacterium. Mattering is now part of the universe" (2019, 91; see also 2016, 69-70). The universe has been transformed from "matter to mattering" (Kauffman 2019, 13; see also 2008).

Therefore P2: the biosphere exhibits properties – notably functionality, agency, meaning, value and creativity – not explainable by or reducible to the physical.

1.3. C: Therefore, radical emergence

P1 and P2 lead Kauffmann to conclude that "life creates the expanding space of possibilities into which it evolves in the nonergodic universe above the level of atoms" (2019, 7). The

[3] Kauffman also argues that the same process of becoming occurs in the economy and in cyberspace (see Gatti et al. 2020 for detail).

biosphere propagates itself forward in time increasing all the while in complexity and novelty. Following its own enigmatic and unpredictable purposes, the biosphere creates new functions, agents, meanings, values and other higher-order properties free from the constraints of physical law (see also Boogerd et al. 2005). This, says Kaufman, calls for a radically new anti-reductionist worldview and a new kind of science in which creativity is recognised as a core component of the universe's ontological makeup (2000, 135-139, 2008 ch. 19, 2016 ch. 14; 2019 epilogue).[4] To understand the kind of functionality found in biology, we need to adopt a higher-level of analysis where we consider the organism and its parts plus the way both form a genealogical and systemic whole. For Kauffman, physics cannot, in principle, state what will have meaning or value in the world. An analysis of such emergent properties requires a level of description that considers agency, minds and what such minds care about. The same goes for creativity. Therefore, C: reductionism fails, and functionality, agency, meaning, value and creativity are radically (i.e. strongly) emergent.

2. The critique: Is TAP logically complete and self-consistent?

Having outlined Kauffman's TAP argument, I will now offer a critique. I will not however argue for or against Kauffman's ontological dualism (as in P1) nor his strong emergence (as in P2). I have done so elsewhere (van der Merwe 2020), and there is exhaustive literature on both dualism and emergence (see e.g. Robinson 2020 for an overview of the former and Gillett 2016 on the latter). I will instead grant Kauffman the truth of his two premises and thereby engage TAP on its own terms. My goal is to tease out the consequences that follow from the TAP argument's conclusion. As we will see, doing so reveals that TAP expresses often tacit, but identifiable, metaphysical commitments, commitments that currently lack, but are in need of, explication. As mentioned in the introduction, a theory must be consistent with its own commitments to be philosophically robust, i.e. logically complete and self-consistent (and I assume that Kauffman intends TAP to be philosophically robust in this sense). Upon analysis, TAP however encounters several potentially insurmountable obstacles that render it an unlikely candidate for philosophical robustness.

[4] Note that Kauffman has diachronic reduction in mind; i.e., physics cannot explain the *functionality* of the biosphere and the coming into existence of its contents. Synchronic reduction of biological entities (like hearts and swim bladders) to the particles and forces of physics is, he thinks, in principle possible. Physicists could, in principle, explain the structure and composition of the heart in terms of fundamental particles and forces, but this could never explain why the *function* of the heart is to pump blood rather than to make heart sounds, for example.

I will now discuss three notably metaphysical commitments in TAP. These are:

MC_1: Scientific realism (section 2.1).

MC_2: Downward causation and teleology (section 2.2).

MC_3: Modal realism (section 2.3).

MC_1 and MC_3 are, I argue, implicit in and/or follow logically from TAP. Kauffman does not however seem to recognise these commitments, and I will conclude that he therefore owes an account thereof. Kauffman is explicit in his endorsement of MC_2, but does not recognise its metaphysical nature and he does not explain exactly how it is supposed to be incorporated into TAP. As with MC1 and MC3, he therefore owes an account thereof.

As intimated in the introduction, note that my aim is not to solve the problems with TAP (assuming they can be solved), nor to offer an alternative thesis. My aim is rather to point out where there are loose-ends that need tying together and to highlight the challenges involved in attempting doing so.

2.1. MC_1: Scientific realism

A clear sense in which TAP contains metaphysical commitments is when the primary denizens of its ontology – functionality, agency, meaning, value and creativity – are not directly observable nor empirically testable by scientific means. Instead, the supposed existence of such things is *inferred* from observation or experiment by way of philosophical argumentation (see Chakravartty 2017 ch. 2 for more on metaphysical inference). For example, because functional language is utilised in our most empirically reliable biological theories, Kauffman infers functionality to be ontologically significant, i.e. mind-independently *real* (section 1). This may be the case, but it is important to note that such a move assumes, not only scientific realism, but also a kind of naturalised metaphysics.

Scientific realism, on the one hand, standardly incorporates the claim that scientific discourse about theoretical entities (at least approximately) denotes extant entities or structures in the world (Sankey 2001). This is clearly what Kauffman is doing with regards to biological functions: functional terms denote because they play a central theoretical role in biology. Naturalised metaphysics, on the other hand, involves the claim that our ontology should be delimited by metaphysical inferences that are informed by and consistent with successful empirical inquiry in the sciences (Chakravartty 2017 ch. 3; see also the collection in Ross et al. 2013). As before, this is part of Kauffman's methodology: his ontology is developed and

inferred in Quinean fashion from 'within' science rather than via analytic or conceptual means, for example.

The idea that scientific terms can thus be 'projected' onto the world via inferential means is however contentious in the philosophy of science. Those who, for example, adopt Humean empiricism (e.g. van Fraassen 1980) or Ramsey-sentence empiricism (e.g. Lewis 2009) reject such metaphysical extrapolations from theory to world. Oddly, Kauffman does not deal with counterarguments to his kind of naturalised metaphysics anywhere in his writings. Such a defence is however surely needed if TAP is to stand up as a legitimate philosophical theory, a philosophical theory containing identifiable metaphysical commitments. Scientific realism and naturalised metaphysics may be justified, but they cannot be assumed. There are well-known defences of both these positions, and Kauffman (or others who endorse TAP) should have no problem finding one that is consistent with TAP (see Ladyman and Ross 2007 for a much-cited defence of scientific realism and naturalised metaphysics; see also Psillos 1999; Chakravartty 2007). The next two metaphysical commitments – MC_2 (downward causation and teleology) and MC_3 (modal realism) – are however not so easily incorporable into TAP.

2.2. MC_2: Downward causation and teleology

As before, my goal in this section is not to engage with the detailed and nuanced philosophical debates on downward causation and teleology (see however Garson 2016; Allen and Neal 2020 for an overview). For the sake of argument, I will instead grant TAP its metaphysical commitment to downward causation and teleology. My goal is to explore whether such a commitment is consistent with and therefore logically incorporable into TAP.

Kauffman states the following about biological functions:

> Hearts exist in the nonergodic universe above the level of atoms *because* organisms need functioning hearts to exist and proliferate. As Kantian wholes, organisms carry along with them their sustaining parts (2019, 7 emphasis added).

This statement assumes downward causation: an organism's needs putatively cause its heart to come into existence.[5] Kauffman is happy to embrace downward causation, and the ostensibly counter-intuitive nature of the above passage is therefore no counterargument in and of itself. According to Kauffman and Clayton,

[5] See Okasha (2012) for an informative argument for downward causation in biology. According to Mayr (1988), functional talk in biology also introduces backward causation.

> extinction is a case of downward causation: when the last member of a species dies, it dies as a whole organism; yet at the same time its death alters the molecular makeup of the biosphere (2006, 520).[6]

To embrace downward causation in this context is however to take a metaphysical position related to mereological part-whole relations, *viz*. wholes can cause their parts to come into or go out of existence.

Talk of downward causation moreover standardly invokes *teleology*. Kauffman recognises, for example, that "once there are biological 'functions', there is a clear sense of teleology, even without consciousness and intent" (2016, 79; see also 2008 ch. 6). He further asks how the adjacent possible has "exploded". The answer (following Nagel 2012) is a "purposeless teleology… made possible by the antientropic processes of the nonergodic universe" (Kauffman 2016, 197 and 204).[7] Parts of the universe – e.g. the biosphere – that (provisionally) defy the 2nd law of thermodynamics display a kind of forceful tendency towards increasing complexity (Kauffman 2019 prologue). This is what Kauffman calls "'elan vital', a nonmysterious but wonderful life force" (2019, 52). Living organisms are created by this elan vital rather than by the dictates of physical law, and thus "represent a new form of matter" (Kauffman and Clayton 2006, 520). These quotes express the kind of strong emergence central to TAP.

That said, if there is such an elan vital operant in the world, and, if it can bring constitutionally new forms of matter into existence, then one naturally wonders after the process or mechanism by which this occurs. In other words, how do teleological phenomena (entities or structure) obtain? Kauffman and Clayton posit five minimal physical conditions that are necessary and jointly sufficient:

> [1] autocatalytic reproduction, [2] work cycles, [3] boundaries or reproducing individuals, [4] self-propagating work and constraint construction, and [5] choice and action that have evolved to respond to (e.g.) food or poison (2006, 502).

The problem with these conditions for the coming into being of teleological phenomena is that teleological language is plainly imbedded in condition 5. "Choice and action" cannot be

[6] See also Noble (2006 ch. 4) for numerous further ostensive examples of downward causation in biology.

[7] In chapter 5 of his (2000), Kauffman however endorses an ontologically significant notion of *purpose* in the universe (see also 2008 ch. 6).

conditions for the strong emergence of teleological phenomena since they are themselves teleological notions.[8] It is however not clear how Kauffman can avoid this circularity. He cannot seemingly list conditions for teleology that are not teleologically loaded – i.e. solely physical conditions – since the whole point of TAP is that teleological phenomena cannot be reduced to or explained by the physical. Any attempt to account for the emergence of teleological phenomena in terms of non-teleological phenomena will work against strong emergence and potentially introduce the kind of reductionism TAP is positioned against.[9]

Thus, teleology remains mysterious in TAP, and we are owed a more metaphysically complete account thereof. This is because teleological notions – notably agency and creativity – are, for Kauffman, not mere pragmatic or linguistic conveniences. Instead, they are ontologically significant phenomena that reside in the world independent of our conceptual projections (Kauffman 2016 ch. 14). Teleological phenomena are also not directly testable – they are not empirical phenomena – and Kauffman's commitment to teleology is therefore metaphysical. The challenge for Kauffman (or those who subscribe to his view) is to offer a metaphysical account of teleology that is consistent with TAP. It however unclear what such an account would look like. Teleology *qua* metaphysical phenomenon must, I take it, be explained by or grounded in either (1) the physical, (2) our conceptual projections, or (3) the divine. If not, it remains unsatisfactorily mysterious (presumably, teleology cannot explain or ground itself). Neither of these three options is however available to Kauffman since – as we have seen – he explicitly denies that any of them can account for teleology. This presents a trilemma that may not be resolvable from within the TAP framework.

2.3. MC_3: Modal realism

Kauffman's core notion of the adjacent possible also ostensibly commits him to some form of modal realism. Recall that, on Kauffman's account, the biosphere creates possibility spaces

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[8] Kauffman and Clayton attempt to sidestep this problem by stating that 'choice'

> applied to bacteria… will have precious few of the connotations that it has in the language game of human agency. The term must therefore be pared down to its absolute minimum, since we are seeking the minimal physical system to which one might apply teleological language (2006, 505).

This is however not helpful since, even in minimal form, 'choice' still plainly denotes a teleological phenomenon of some kind.

[9] It is also not clear how causation (whether upward or downward) can cross Kauffman's strict ontological divide between the ergodic and non-ergodic universe (section 1) (see van der Merwe 2020).

that in turn "suck" the biosphere forwards (section 1.2). As before, these niches are not merely a practical feature of our modelling practices. Instead, they are supposed to be ontologically significant; they are objectively real in TAP. The TAP argument, on my reading, stands or falls with modal realism.

Kauffman and Gare (2015) endorse the notion of real possibility, even if they do call it modal realism. They argue that, not only is real possibility necessary for the free will that scientific practice assumes, but it is also imbedded in scientific methodology. Scientists have to assume that their experiments could have turned out otherwise and that they could have done otherwise in setting up those experiments. Kauffman and Gare conclude that there exist what they call "res potentia" or "ontologically real Possibles [sic]". Possibles include, not only biological niches, but also objects and properties that *de facto* reside in possibility space awaiting actualisation, i.e. await becoming "res extensia" or "Actuals [sic]" (see also Kauffman 2000 ch. 7; 2016 chs. 3, 4 and 7). This "post-Newtonian" process is supposed to work as follows:

> Actuals emerge, typically unprestatably and are new in the universe, unentailed by any law… [They have] boundary conditions that enable a new adjacent possible, but unprestatable, 'set' of opportunities into which evolution 'flows', creating new actuals that create ever new adjacent possibles. This is, the emergent, creative, unentailed, becoming of the evolving biosphere, beyond law [sic] (Kauffman and Gare 2015, 240).[10]

Kauffman is thus committed to what philosophers conventionally call *possibilia*. In TAP, these are extant but not yet actualised Possibles: the objects and properties populating the adjacent possible. Once there are lungfish, for example, the swim bladder comes into existence in the adjacent possible even if it is not yet actualised within the biosphere (recall section 1.2). Lungfish do not only possess their actual functional properties, but also their potential future functional properties.

As before, TAP's commitment to modality is metaphysical rather than empirical since we obviously cannot perform experiments on non-actualised things. Some metaphysical account of modality that is, not only cogent, but also supportive of TAP is however missing from Kauffman's general body of topical work. This is surprising given, not only TAP's

[10] Kauffman (2016 ch. 7) also argues (via metaphysical interpretation of quantum mechanics) that Possibles come into and go out of existence instantaneously thereby violating the so-called causal closure of the physical.

philosophical nature, but also modality's central role therein. The question is whether such an account can be developed.

One of the core issues with modal realism relates to the question of what, if anything, *grounds* one's range of possibilia. In other words, what, if anything, determines which kinds of possibilia reside in possibility space? There are, I propose, three options: natural law (as in Ladyman and Ross 2007), our intuitions (as in Lewis 1986) or nothing (as in Meinong 1960) (see Yagisawa 2010 for more on the metaphysics of possible things). That is, the entities or structures that will come to exist in the future course of evolution may be grounded in or determined by

GD_1: natural law,

GD_2: our intuitions, or

GD_3: nothing.

Either option is however problematic for TAP.

Regarding GD_1, Kauffman cannot ground modality in natural law – understood as necessary or deterministic law – since one of TAP's central theses is that the biosphere propagates independent of such laws (section 1). Kauffman does nonetheless, at times, suggest that there may be a "fourth law of thermodynamics for self-constructing biospheres", a kind of power law that governs increasing complexity in the universe (2000, 207; see also 2008 chs. 7 and 8, 2016 ch. 8). Kauffman however considers this putative fourth law to be emergent in the same way that the biosphere is emergent. Following Smolin (1997), he thinks that the laws of nature change through time as complexity increases in the universe (Kauffman 2000 ch. 10). Mendel's law, for example, is emergent from lower-level laws, and it may, in turn, give rise to new, previously non-existent laws. Such laws cannot however ground or determine the biosphere's *emergent* possibilia since they themselves emerge with the biosphere (Kauffman 2016 ch. 14). We require something extrinsic – something non-emergent – to ground or determine that which is emergent. This option appears to be outlawed by TAP own anti-reductionist tenets, however.

GD_2 will not work for the same reason: minds that form intuitions are part of the emergent biosphere. Further, modality in TAP cannot be grounded in or determined by our intuitions since the becoming of the biosphere is supposed to be unprestatable: "not only do we not know what will happen, we do not even know what *can* happen" (Kauffman and Gare 2015, 239 original emphasis). As with GD_1, GD_2 is ruled out due to being inconsistent with core tenets of TAP.

Regarding GD_3, Kauffman, at times, suggests that the becoming of the biosphere is "foundationless"; "its becoming is *unentailed*" (2016, 196 original emphasis). However, the range of possibilia – what is genuinely possible versus only imaginatively possible – is surely not a matter of anything-goes. Kauffman will, I presume, reject the idea that flying spaghetti monsters and cannibal zombies reside in the adjacent possible. There must consequently be some *constraint/s* – laws (?) which are not themselves emergent – that ground or determine what kinds of possibilia occupy possibility space. If possibilia remain undetermined and ungrounded, then their range remains unsatisfyingly mysterious in TAP. Like GD_1 and GD_2, GD_3 thus appears logically incompatible with TAP.

As with downward causation and teleology, it is unclear what the way forward should be in developing a metaphysics of modality suitable for TAP.[11] The challenge is not to list the possibilia that reside in the adjacent possible (Kauffman and Gare 2015, 240-241), but rather to state what grounds or determines the kinds of possibilia that could obtain so as to avoid anything-goes. Committing to modal realism (whether explicit or implicit) naturally requires that one defend some cogent metaphysics of modality. As far as I can tell, TAP – in its current form anyway – is incapable of satisfying this requirement.

Conclusion

According to TAP, in the

> nonergodic universe above the level of atoms, the biotic world surges beyond our saying, beyond equations and calculation… beyond… rule and line, and into the exploding adjacent possibilities life itself creates (Kauffman 2019, 12).

For Kauffman (e.g. 2008 chs. 16-18, 2016 chs. 15-17), this kind of breaking free from physical constraints is, not only the fact of the matter, but can also be inspiring. Biological beings, like us, are not nomologically bound automatons; instead, we are the volitionally liberated deciders of our future. This normative overlay to TAP is, not only seemingly sincere and well-intended, but also part of the theory's intuitive appeal. As we have seen, TAP however faces several problems. Notably, it incorporates plainly metaphysical commitments, but does not account for these commitments in any philosophically thorough kind of way. This renders TAP logically

[11] According to Jenann Ismael, modal realism commits one "to the existence of non-actual possible worlds, and it has never been clear what these are, or how we could know about them" (2017, 109). I suspect that Kauffman will find possible worlds metaphysics uninviting (see Divers 2002 for an overview).

incomplete. As argued, attempting to develop such an account moreover introduces inconsistencies with TAP's own central tenets. This renders TAP self-inconsistent. Thus, if TAP is both incomplete and self-inconsistent, then it is not philosophically robust in the way it aspires to be (recall the introduction).

I am sceptical whether this tension can be resolved from within the TAP framework. If subscribers to TAP nonetheless wish to do so, much philosophical work needs to be done. No amount of scientific investigation will help since TAP's metaphysical commitments – MC_1-MC_3 – are *au fond* beyond the remit of empirical testing.

Alternatively, subscribers to TAP could forego metaphysical inference, thus rendering TAP a purely empirical theory. This could perhaps involve adopting a Humean or Ramsey-sentence approach that putatively strips away TAP's metaphysical commitments. The outcome would however surely be unsatisfying to subscribers to TAP since none of Kauffman's radical methodological, ontological and normative conclusions would follow from such a deflated reinvention of the theory.

In sum, TAP either needs to incorporate an explicit and cogent metaphysical account of MC_1-MC_3 or it needs to be significantly overhauled as a putative philosophical thesis. I suspect that the latter is the more logically viable option. I will nonetheless leave it to advocates of the theory to sort through these issues.

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