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Enablement, the adjacent possible and the becoming of the biosphere

Book review of Stuart Kauffman: *A world beyond physics: the emergence and evolution of life*. Oxford University Press, New York, 2019, ix + 151 pp, $24.95 HB, ISBN: 9780190871338

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Physician, turned complexity guru, turned public intellectual Stuart Kauffman's new book *A world beyond physics* offers the most recent incarnation of his deep and evolving worldview. As before, there is emphasis on familiar Kauffmanian themes such as non-equilibrium systems and emergence. Also emphasised, however, are newer philosophically loaded concepts that call out for critical analysis. These include *enablement, the adjacent possible* and *the becoming of the biosphere*. In this review I will, first, summarize the book, then, analyse some strengths and weaknesses of Kauffman's overall argument, and lastly, conclude by weighing up what has preceded.

The book consists of eleven chapters. In Chapters 1 and 2, Kauffman argues that "the universe has made all the possible types of stable atoms", yet only a "tiny fraction" of "all possible complex things" such as proteins (2-3). Therefore, the world consists of two domains: the physical *ergodic* and the non-physical *non-ergodic*. "'Ergodic' means, roughly, that the system visits all its possible states over some 'reasonable' time period", while "'nonergodic' means that a system does not visit all its possible states" (4). This is the distinction between the domain of physics and the *biosphere*. The latter is not reducible to the former. Physics cannot account for, among other things, biological *functions*. The explanatory arrow points upward not

downward. This is "radical emergence" far removed from Newton's clockwork world of strict cause-and-effect.

Having disposed of ergodic reductionism, Kauffman sets out to construct a suitably non-ergodic model for the origin and propagation of life. Organisms are "Kantian wholes", he says, "the parts exist for and by means of the whole" (8). Kantian wholes concomitantly propagate themselves and *create* the world. In Chapters 3 to 7 Kauffman links some of his previous research on collectively autocatalytic sets (Kauffman 2000) with recent theoretical work by Montévil and Mossio (2015). A detailed exposition of this fascinating scientific work is beyond the scope of this review. I focus here on the philosophical themes in the book. However, I strongly recommend anyone interested in the origin of life to take a closer look at Kauffman et al.'s promising bio-systems models.

Chapter 8 introduces the important notion of *agency*. Kantian wholes are "autonomous agents" decides Kaufmann. "Given agency, meaning exists in the universe"; the universe is transformed from "matter to mattering" (12-13). "We have the rudiments of soul and vitalism" (93). Agents seize opportunities, making "even more opportunities for others in … *adjacent possible* niches" (106, my emphasis). "The total system 'explodes' in a self-amplifying way into the very adjacent possible it itself creates" (12). We cannot know — even in principle — what the *becoming of the biosphere* will be. In Chapters 9 to 11, Kauffman expands on his central notion of *enablement*. There is no formal sense of causation in biology; enablement, instead, has the necessary explanatory scope and power. Agents, "by coming into existence, can constitute a new 'context' and opportunity that does not cause but 'enables' yet further life forms … to come into existence" (110).

This is heady stuff. A brief summation is in order. Kauffman claims that the biosphere is the "nonergodic world above the level of atoms" (95). No laws can account for the becoming of the biosphere; the non-physical cannot be reduced to the physical. The biosphere includes radically emergent properties of agency, meaning and mattering. Moreover, neither physics nor standard Darwinism can account for the key notion of enablement, *viz.* creativity/possibility. Therefore, life is "explosively rich in its emergent complex, surging, unprestatable, and diversifying becoming — a myriad miracle of which we are part" (125).

I will now offer some praise and criticism. The book has several strong points. First, Kauffman is correct that concepts like 'biological function' cannot be reduced to theoretical terms in physics. Instead, improving current biological theories and models will involve increasing their scale-relative parsimony and perspicacity. Second, in contrast to rival gene-centric approaches, Kauffman and colleagues' systems-centric approach arguably captures the dynamism of evolving life best.

However, Kauffman's derivative philosophical assertiveness comes at a price. Troubling aspects of the book include an over-reliance on arguments by analogy plus unjustified commitments to modal realism and top-down causation. Moreover, despite purportedly being "unprestatable", Kauffman himself makes several statements about the becoming of the biosphere; for example, that life is abundant in the universe (x). Nonetheless, I distil my criticisms to the following three primary issues.

1. Kauffman is fast-and-loose with key terms in his account, specifically his central notion of *enablement*. More conceptual precision is needed.
2. Kauffman's irreducibility argument appears to involve an *asymmetric dichotomy* between ergodic and non-ergodic that primes his book's radical conclusion.
3. Kauffman assumes a kind of *realism about biological models*. Without argument, he draws far-reaching metaphysical conclusions from local theoretical terms.

Let us briefly consider each criticism. First, enablement appears to be *the* central metaphysical notion in Kauffman's account. He distinguishes between the non-physical biosphere being "based on" versus being "enabled" by the physical (127-128). Unfortunately, however, it is not clear on what it means to be based on versus enabled by. We are only told that enablement is "making possible" or "niche creation" (117); "the current actual enables… the adjacent possible" (133). Presumably, enablement approximately resembles *realizability*. At times, however, enablement appears to involve more than realizability. It also connotes creativity, meaning and mattering because agency itself can enable. One wonders whether enablement is a process, a function or perhaps a *monad* (surely not a mechanism). Enablement seems to contain features of both substance and structure, both body and mind. It is doing the philosophical heavy-lifting, yet there is no concise definition in the book. Kauffman's metaphysics appears unstable.

Second, Kauffman states that the domain of physics is ergodic, while the domain of the biosphere is non-ergodic. To support this metaphysical dualism, he asks us to choose between the universe making all stable atoms and all complex things. Note, the distinction is not between all atoms *simpliciter* and all complex things *simpliciter*, nor between all *stable* atoms and all *stable* complex things. Crucially, this asymmetry allows Kauffman to delineate between physics as ergodic and non-physics as non-ergodic. If choosing between all atoms *simpliciter* and all complex things *simpliciter*, his claim that the universe has created all atoms is unsupported. Some future particle accelerator, for example, may create new atoms. Both the physical and the biosphere come out non-ergodic. Similarly, if choosing between all *stable* atoms and all *stable* complex things, his claim that the universe has made only a "tiny fraction" of complex things is unsupported. Perhaps, the complex things we observe just about exhaust the universe's possible stable complexities. Both the physical and the biosphere come out ergodic. Kauffman presents a false dichotomy that skews things in favour of his conclusion of radical emergence. This lopsided physical/biosphere dualism premises much of the book's overarching argument.

Third, despite placing a heavy burden of proof on physics to account for biological phenomena, Kauffman places no such burden on biology to account for so-called higher domains of enquiry. Without argument or data, he extrapolates from biological models to ontological conclusions about *mind, semantics, norms* and even *spirit*. He apparently sees no distinction between all 'non-physical' domains. If conceptually detached from the constraints of physics, it seems we are free to posit *agency, meaning, mattering* and *soul* as substantial without logical or empirical justification. Here is an example of the kind of rapid domain-spanning assertive progressions one finds throughout the book:

> consider a bacterium swimming up a glucose gradient. The sugar matters to the bacterium. Mattering is now part of the universe. Agency introduces meaning into the world! Agency is fundamental to life. (91)

Kauffman offers no rational support for this logical hop-skip-and-jump from biology to norms, mind, semantics and even metaphysical foundations. If one is going to wax authoritative about age-old philosophical puzzles — e.g. crossing Hume's dreaded is-ought gap (94) — then logical rigor should precede one's conclusions.

In sum, Kauffman's latest book makes for stimulating reading. Despite a penchant for hyperbole, his prose is reader-friendly and thought-provoking. As I have suggested, the scientific aspects of his work are fascinating. However, when extrapolating from biological models to far-reaching metaphysical conclusions, he falls noticeably short. Core theoretical concepts and bold ontological posits require detailed logical and empirical support. Merely demonstrating that physics cannot account for theoretical terms in biology does not unleash us from the constraints of scholarly rigor. Nonetheless, I highly recommend Kauffman's book to anyone interested in the ongoing scientific enterprise to model the transition from physical to living systems.

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