Reviews

TIMOTHY E. EASTMAN. *Untying the Gordian Knot: Process, Reality, and Context.* Lanham, MD: Lexington Books, 2020. 344 pages. [Reviewed by MATTHEW D. SEGALL, Philosophy, Cosmology, and Consciousness Program, California Institute of Integral Studies. Email: <msegall@ciis.edu>.]

It was nearly a century ago, in the midst of the quantum and relativistic revolutions in physics, that Whitehead realized scientific progress had reached a turning point:

> The old foundations of scientific thought are becoming unintelligible. . . .What is the sense of talking about a mechanical explanation when you do not know what you mean by mechanics? If science is not to degenerate into a medley of *ad hoc* hypotheses, it must become philosophical and must enter upon a thorough criticism of its own foundations. (*SMW* 24)

Despite Whitehead's warning, the 1920s also saw the rise of a positivist prohibition on speculative metaphysics, handicapping progress into the foundations of postclassical science and producing precisely the fragmented medley that he feared. Fortunately, a growing chorus of interdisciplinary scientists is taking up the philosophical work left unfinished by the early-twentieth-century founders of quantum theory. In *Untying the Gordian Knot: Process, Reality, and Context*, Timothy E. Eastman, plasma physicist-cum-philosopher, adds his voice to the ensemble, offering the "*Logoi* framework" as a meta-theory that aims not only to make ontological sense of quantum physics but to integrate it with several other emerging twenty-first-century frameworks, including complex systems science, biosemiotics, and category theory. This alone would make Eastman's book worthy of careful study, but he goes even further, sketching the plan for a bridge between science (or "the way of numbers") and the human ethical and spiritual spheres ("the way of context"). Despite the grand scope of his inquiry, Eastman remains humble and conciliatory: the *Logoi* framework "is not post-anything but a proto-worldview" (11) that seeks to balance both theory and story, both systematic rigor and open-ended adventure (14). Eastman's masterful synthesis of dozens of

cutting-edge researchers across numerous disciplines is impossible to fully summarize in this short review. Thus, in what follows, I focus on a few of *Untying the Gordian Knot*'s important contributions to the birth of a process-relational science.

Eastman decided to study physics and philosophy not only because he wanted to understand the physical world, but because from a young age he intuited that this "wondrous whole" contained layers of meaning deeper than the merely measurable (1). Natural science has allowed human beings to reach beyond the mundane proportions of their sense organs and species-specific *umwelt* toward extreme magnitudes of space and time. Telescopes extend our eyesight across vast distances of intergalactic space; microscopes bring us into the nuclei of cells and even atoms; inferences from radioactive decay rates of certain isotopes allow us to infer the age of fossils millions or billions of years into the past. Such techniques have dramatically expanded our understanding of the universe and our place within it. But in extending our senses to scales they were not evolved to perceive, often while using empirical concepts derived from human-scale perception, we run the risk of succumbing to the sort of model-centric literalism that imagines we possess an outside God's eye view of an already finished universe. Eastman seeks to re-embed the scientific perspective within the evolving universe that gave rise to it, such that "the most fundamental notions [of natural science] can be inferred from normal human experience" (5). This follows from Eastman's commitment to the Whiteheadian ideal (emphasized by Randall Auxier and Gary Herstein) that "concrete existence explains the abstract aspects of experience and not vice versa" (7, 196).

Eastman carefully deconstructs the conceptual impediments to philosophical integration of postclassical science, such as "actualism," "nominalism," and "determinism" (89), arguing that potentials (or *potentiae*, a term Eastman borrows from Ruth Kastner, Stuart Kauffman, and Michael Epperson) have a creative role to play that both upsets notions of (efficient) causal closure and reintroduces formal causes into our accounts of natural processes. While quantum physics has forced the issue, Eastman points out that it is misleading to construe even the formalisms of classical Newtonian physics as though they entail strict determinism, since all such modeling frameworks make assumptions about initial and boundary conditions, relevant scales, and domains for meaningful solution (94). Granting *potentiae* real participation in the physical world not only allows science to consider the anticipatory capacities and creative

agency of biological organisms (including that of scientists themselves) in a nonreductive way. It also resolves longstanding quantum puzzles, which resulted from trying to force fit a classical mechanistic ontology to results that should indicate the need for a new, process-relational ontology (54). Building on the Relational Reality model of Epperson and Elias Zafiris, Eastman describes the evolution of quantum events from pure potential to probabilities to actualization when measured (a process involving both logical conditioning and causal reiteration) (38). Eastman further argues that acts of measurement are not passive observations of already existing facts but rather themselves establish new facts. There can be no ultimate causal closure, either for finite systems or for the universe as a whole. The ontological unrest of newly emerging facts perpetually reopens any such closure. Eastman here suggests a corollary for finite physical systems to Kurt Gödel's incompleteness theorems in logic (77). The universe thus becomes a cumulative succession of "actual occasions of experience," wherein *potentiae* grow together with actualities by linking local causal interactions with global logical constraints in the ongoing process of realization. This process includes both a standard (Boolean) dyadic logic of actualizations (*res extensae*) and a triadic logic of potentialities (*res potentiae*) (23). Eastman argues that "dyadic relations do not, in fact, exist in the real world, [only in] the world of abstract modeling" (27). This is because context is inevitably involved and because the relationship between potentiality and actuality is inherently asymmetrical, from whence comes the arrow of time.

Eastman's *Logoi* framework thus carries forward Whitehead's crucial distinction in *Process and Reality* between the logical order of concrete events ("genetic division") and the causal order of metrical spacetime ("coordinate division") (43–44). The former, rooted in fundamental quantum processes, is given primacy, while the latter, rather than being conceived of as a preexisting continuum serving as a container *for* processes, is secondarily emergent *from* such processes (68). In Eastman's words:

> Quantum physics exemplifies the fact that physical extensiveness (standard spacetime description) is fundamentally topological rather than metrical, with its proper logico-mathematical framework being category-theoretic (relations of relations) rather than set-theoretic (sets of things). (71)

Grasping the significance of Eastman's *Logoi* framework may be aided by contrasting it with popular actualist accounts. Eastman critiques the

physical "theory of everything" articulated by Sean Carroll in his book *The Big Picture: On the Origins of Life, Meaning, and the Universe Itself.* Carroll takes up the God's eye perspective by offering a single "core theory": an equation combining quantum mechanics, spacetime, gravity, matter, the Higgs field, and other forces, which he claims leaves no room for new aspects of the universe that are not already well understood. Eastman points out that, while the components of this core equation represent great achievements, in practice no one has ever succeeded in combining them into a practical model or simulation. Carroll's core theory thus amounts to no more than a mashup and is not anywhere close to being a working equation (126). On Eastman's reading, Carroll makes several unstated metaphysical assumptions, including actualism, physicalism, and causal closure, leading him to mistake an amalgam of dyadic input-output models for a coherent ontology, as though they could serve as an ultimate explanation for the universe (127). Rather than accepting Carroll's actualist rendering of the Feynman path-integral formulation of quantum physics (where electrons are assumed to take every path, with the largest probability being given to that path that approaches classical physics), Eastman argues that "physical relations emerge from [the] multiple sampling of *potentiae* pre-space, which is operationally handled by the principle of least action, reflecting optimization of relations of relations in this pre-space" (138). Rather than prematurely limiting our creative cosmos to the idealized deductivist models of current physics, or suggesting untestable "scientific exotica" (82) like the vast ontological overflow of actualized possible worlds, as in the "many-worlds" interpretation of quantum physics, Eastman leaves open the possibility of genuinely novel emergence within the only universe we could ever know anything about.

Whitehead's cosmology, along with the ideas of Charles Sanders Peirce and contemporary physicist Lee Smolin, are often interpreted as implying that physical "law" is a matter of empirical probability instead of being metaphysically grounded. Since deism is no longer a live option for scientists (as it was in Descartes's and Newton's day), very few practicing physicists have attempted to ground "law" metaphysically (130). The closest thing contemporary physics has to such a metaphysical ground for physical laws are "symmetry principles." But from Eastman's perspective, these principles remain groundlessly circular descriptions unless accompanied by a process-relational ontology. Peirce attempted to reformulate laws as habits, but Eastman worries this may be a category error that, despite Peirce's realist intentions, falls prey to nominalism. For Eastman,

genuine habits can only be said to emerge at the biological level. Without wanting to affirm deductivism, he nonetheless thinks necessity must have some purchase in Nature for many of the findings of modern physics to make any sense. He thus argues that Nature's laws derive, not from any deductive necessity, but rather from the conditional contingency of trajectory optimizing histories (e.g., the Principle of Least Action) (131). He compares these trajectories to Leibniz's "striving possibles" (133).

In addition to its paradigm remaking implications for physics, the *Logoi* framework's fundamental distinction between the Boolean domain of actualized measurements and the non-Boolean domain of pre-space *potentiae* also has important implications for the study of human consciousness. Rather than reducing our concrete experience of mental processing to abstract correlations among measurable brain states, the *Logoi* framework allows us to take seriously our sense of being conscious agents capable of some degree of decisive influence within the always already ongoing world-process. With the inclusion of the realm of *potentiae* into physical ontology, human consciousness no longer needs to be thought of as an anomalous intruder into an otherwise well-behaved mechanical universe. Instead, our conscious experience offers us an intimate window into the functioning of *potentiae* in the broader course of Nature. This is because our everyday mental capacities involve tapping into and expressing "ontologically genuine remainder[s] of real possibility" (84) latent within physical process. It follows that popular claims on behalf of artificial intelligence systems are on the verge of realizing effectively human levels of consciousness and cognition are rooted in faulty metaphysical presuppositions. Artificial intelligence systems are entailment devices limited to input-output (Boolean) logic alone, and so cannot tap into the realm of *potentiae* in the way biologically evolved, historically emergent minds can (98).

Eastman synthesizes important insights from a variety of researchers to contribute much needed clarity to the scientific understanding of the role of emergence in Nature. Emergent physical entities are so described because, as novel wholes, they are not derivable either from the stuff of which they are made or from the laws of physics (111). Eastman distinguishes emergence as a synchronic, global hierarchical process that builds on diachronic causation at the local scale. Many basic causal and emergent processes are rooted in multiscale quantum field processes (Eastman gives the example of space plasmas, whose emergent processes range from planetary to galactic scales) (112). Emergence is thus not

merely a matter of epistemic limits to reductive explanations but rather a consequence of the influence of quantum processes and their associated *potentiae* across all physical scales. In the *Logoi* framework, causation is interpreted more broadly than just the dyadic correlation of facts typical of actualist frameworks. From within an actualist framework, any novelty or emergence can only be regarded as an epiphenomenon arising from random error or chance. Adequately understanding genuinely emergent entities and processes requires symbolic bridges, as knowledge presupposes a distinction between knower and known, and thus the need for mediation (113). Eastman proposes Whiteheadian "prehension" as one such symbolic-conceptual bridge. Eastman shares Charles Hartshorne's sense that prehension is the most powerful metaphysical generalization ever accomplished (159n18), as it allows all sorts of relations (e.g., memory, perception, knowledge, causality, spatial, temporal, subject-object, God-world, etc.) to be accounted for in terms of one generic type. Further, the metaphysics of prehension implies that all physical relations are fundamentally asymmetrical in both logical and temporal senses (76). Prehension can be variously understood as a philosophical embodiment of field theory (following Whitehead's original inspiration), as the ontologization of the mathematical function (following James Bradley's work), and as an account of quantum process (113–114). In light of Whitehead's prehensional account of causation and emergence and Epperson and Zafiris's applications, Eastman argues that a strong case can be made for the idea that all macro-systems (including relativistic spacetime) are ontologically emergent from fundamental quantum processes.

Eastman creatively expands upon Whitehead's process philosophy without remaining unduly tied to the latter's categoreal scheme. He emphasizes Leemon McHenry's interpretation of Whiteheadian prehensions as "concrete functions" rather than as "abstract relations" (40), thus contrasting Whitehead's "third approach" to his former collaborator Bertrand Russell's nominalistic logical atomism. Prehension is defined in its physical mode as "the present occasion's absorption of past actual occasions in its process of self-creation," as McHenry emphasizes. This leaves out the role of conceptual prehensions in Whitehead's scheme, that is, the present occasion's ingression of potentials or eternal objects in its process of self-creation. McHenry appears to question the need for Whitehead's eternal objects (at least if they are given a "Platonic emphasis," in Eastman's terms) (47). Eastman claims his account of a diachronic process in terms of pre-space *potentiae* plays a role similar to that of Whitehead's

"prehensive unification" first introduced in *Science and the Modern World.* Despite approving of Whitehead's perspectival account of the relation between universals and particulars (103), Eastman sometimes indicates a desire to distance himself from Whitehead's eternal objects, thus implying that there may be important differences between his landscapes of *potentiae* and the realm of eternal objects. This is a fertile area for further philosophical exploration that is beyond the scope of this brief review. Nonetheless, a few suggestions can be offered.

One way of beginning such an exploration stems from asking whether the choice of realism over nominalism as regards the status of form in Nature entails Platonism. Eastman thinks not (92), but given that Plato wrote dialogues and not doctrines, it all depends on what is meant by "Platonism." Regardless of the nature of his divergence from Whitehead's eternal objects, they clearly share a rejection of nominalism. Eastman puts forward an argument against nominalist actualism that is rooted in quantum *potentiae* that integrate local-global interactions without themselves having any specific spacetime location. They are *generals,* in Peirce's sense, serving as logical constraints on physical process. From Eastman's point of view, admitting *potentiae* back into Nature is far more parsimonious than the actualist/nominalist interpretations of quantum theory (e.g., the many-worlds and multiverse hypotheses) (94).

Eastman concludes his book with an attempt to link human and cosmic *logoi* in search of some sense of the deeper meaning of our existence. Careful to avoid any monological fixations, he builds on George Ellis's "Kenotic morality," wherein human values like truth, goodness, and beauty "reflect the forces or intentions that created the universe . . . as part of the deep structure of the cosmos," in Ellis's terms. Eastman also amplifies Robert Neville's worry about the "enormous damage to human civilization [resulting from] the loss of value-reference and realistic valuation in modern Western science" (245). With characteristic caution and modesty, Eastman seeks to contrast his own *Logoi* framework, which aims at "evidence-based methodology," with the "advocacy-based thinking" that is more appropriate in cultural and political spheres (247).

In the final pages, Eastman honors the Dakota peoples, upon whose land he first had the spiritual experience that initiated his inquiry into the nature of reality:

> In confronting the psychological challenges of nihilism, denialism, and assorted despairs of contemporary life, in facing up to the physical threats of war, pandemics, human suffering, and in newly realizing

> the deteriorating of earth's climate, ecology, and habitability, can we somehow embrace what we have learned through science and philosophy and what we may yet draw on from indigenous and other spiritualities so as to bring into being a world in which we humans can live and flourish over the long term? (274)

Eastman has succeeded in making a major contribution toward such an integral embrace.

WAHIDA KHANDKER. *Process Metaphysics and Mutative Life: Sketches of Lived Time*. New York: Palgrave Macmillan, 2021. 202 pages. [Reviewed by KAMILA KWAPIŃSKA, University of Kent. Email: <K.Kwapinska@kent.ac.uk>.]

Process Metaphysics and Mutative Life: Sketches of Lived Time is the first title in the new series Palgrave Perspectives on Process Thought, which promises publications that take an innovative, interdisciplinary approach to philosophy. Khandker's book proposes new methods for studying complex interactions of living processes by combining process philosophy with concepts from biology and problems in science. Drawing mostly on Alfred North Whitehead and Henri Bergson, but also on other key process thinkers like Charles Hartshorne and William James, she explains issues ranging from formalism, evolution, and symbiogenesis to the theory of special relativity, black holes, and cybernetics. Khandker demonstrates how process metaphysics can be used to resolve issues in a number of case studies by pointing to concepts that have the capacity to explain and resolve theoretical gridlocks. Perhaps most importantly, the book outlines a method that brings the problems of panpsychism and ecology together. Panpsychist elements enrich the philosophy of biology insofar as they provide an outlook on ecology that is not based "on some separate specialism that we term 'ethics,'" but on the vitalism of life functions (6–7). Khandker argues that rethinking the relations between forms of life is crucial in a time of environmental crisis. The book's focus on ecological interpretations of process metaphysics and "lived times" underpins the chapters where in each we can find its application to a set of specific scientific issues.

In "Transmutation," Khandker argues that Whitehead's method of looking at nature as interlocking processes on multiple *scales* can help to clarify issues in shifts in species status of fluctuating and mobile populations (28). When can we classify them as "successful," invasive, or despotic? How can we monitor them? Biology already looks at nature