this genre that have multiple authors, this book has only one, and this gives it a coherence not always achieved elsewhere. The content contains a mixture of original research (e.g., studying historical textbooks going back more than two centuries, with some reference to original texts) and reliance on the work of other historians. In addition to the main historical story, an interesting feature is the side story of how misconceptions have been reported in textbooks over the years, even continuing to the present.

In Part 1, the book focuses on seven "myths" concerning history, science, and Christianity. In order, the myths treated are (1) the medievals thought of the universe as small and that somehow small was inferior; (2) the medieval period is justifiably considered "dark" with regard to knowledge; (3) medievals believed the earth to be flat; (4) Giordano Bruno should be considered a martyr for science; (5) Galileo was imprisoned for his science; (6) a Copernican view constitutes a demotion and humbling of the medieval view because it removes us from the center; and (7) when we meet extraterrestrial beings (ET), the meeting will bring about a kind of scientific enlightenment.

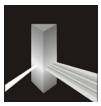
When I first encountered the book, I was not sure why these particular myths were chosen, and why they were ordered in this way. However, upon reading, I found that the myths and their ordering constitute a natural progression, from one to the next. And in a certain sense, these seven myths constitute a suitable representative sample to stand in for the many that could be discussed. As stated later in the book, the first three myths belong to the medieval period, whereas the next three are associated with the early modern period. The last relates to a yet future hypothetical event, one that is talked about with a kind of secular religiosity in passages quoted. In many cases, you can see a progression; once a myth is created, it gets picked up and propagated by those who would like to promote a particular cause. Most of these myths are myths in the usual sense of a false story. But the last falls into another category, as an "imaginative archetypal story that shapes a culture's identity and dominant worldview" (p. 5).

Following Part 1, the second part of the book is devoted, in part, to the question of why the myths continue to be propagated, and, in part, to an elaboration of the misconceptions in order to place them within a fuller context. Much of this second part adds to and enhances the arguments in the first part. For example, in the first chapter, the theme of ET is revisited and tied to a science fiction theme, and the next chapter discusses how science television shows such as *Cosmos* (both the Sagan version and the Tyson version) propagate the theme that science represents progress, putting it in opposition to the "outmoded" religion of the past. A later chapter reveals one of the more interesting facts. In considering a large number of textbooks used in American education, from the seventeenth century to the present, virtually none of the myths appeared until around the early nineteenth century, suspiciously closely following the so-called "Enlightenment" period. One of the earliest texts discussed is one written by Kepler, which is portrayed as a splendid example of compatibility between science and Christianity.

I have read other books in this general genre, yet I still learned much from this one. Aside from the usual stories of Bruno and Galileo, there are also lesser known stories such as Sagan's use of Hypatia to justify an imagined war between science and Christianity, and Tyson's telling of false historical stories to justify his position, a practice surprisingly endorsed by historian Joseph D. Martin for the "greater good" (p. 152).

Who might be interested in reading the book? I would recommend it to anyone who is interested in the history of science and Christianity in general. In particular, Christians in science can benefit from the broader theme of knowing what the myths are that continue to be propagated, with an eye toward revealing them to others when the subjects come up. If you have not read much on this subject, this book would be a good place to start.

*Reviewed by Donald N. Petcher, Professor of Physics, Covenant College, Lookout Mountain, GA 30750.*



## Physics

**THE PHYSICS OF EMERGENCE** by Robert Bishop. San Rafael, CA: Morgan & Claypool, 2019. 112 pages. Paperback; $50.00. ISBN: 9781643271538.

What options are available when thinking about the physical and material universe? Are all phenomena and behaviors reducible to the fundamental laws of nature, perhaps in a single comprehensive materialist "theory of everything"? Or must any comprehensive account of the material universe be necessarily dualist, perhaps even one in which physical theory needs to be supplemented by some type of non-material essence or possibly by divine intervention? Or is there a middle way, one in which reductionism is inadequate and dualism unnecessary? In this book Robert Bishop affirms the latter by arguing that the structure of physics itself indicates that the universe displays contextual emergence, a type of emergence in which lower-level structure is insufficient to account for higher-level properties and behavior,

owing to the role contextual and contingent factors play in shaping higher-level structure.

Bishop, currently John and Madeleine McIntyre Endowed Professor of Philosophy and History of Science at Wheaton College, is well positioned to address such a challenge. He earned a BS and MS degree in physics and a PhD in philosophy, all from the University of Texas at Austin. He specializes in the foundations of the physical and social sciences, particularly on determinism and free will, irreversibility, and theories of mind and consciousness. Bishop codeveloped the concept of contextual emergence along with Harald Atmanspacher (Robert C. Bishop, "Patching Physics and Chemistry Together," *Philosophy of Science* 72, no. 5 (2005): 710–22; Robert C. Bishop and Harald Atmanspacher, "Contextual Emergence in the Description of Properties," *Foundations of Physics* 36, no. 12 (2006): 1753–77). In *The Physics of Emergence*, Bishop further explains the concept and argues that it is grounded in physics.

Given the checkered history of the concept of emergence with a spectrum of diverse meanings, any work on emergence is well served by explaining its use of the term. Bishop does so clearly and succinctly in the introduction and first chapter. He notes the common belief among the scientific community in reductionism, whereas emergence denies these reductionist views without resorting to dualism. Essentially, reductionists believe "that everything else in the Universe reduces to the play of elementary particles under elementary forces (or the action of quantum fields)" (p. xii). In contrast, emergentists believe that fields such as condensed-matter physics, biology, or psychology study phenomena that "aren't explainable or derivable from elementary particles/forces …" (p. xii).

In the first chapter, Bishop provides a brief but helpful history of emergence. He cites key comments from luminaries such as Einstein, Pauli, Schrödinger, Anderson, and Laughlin that indicate an openness to emergence while the scientific community tended to hold firmly to reductionism.

In the second chapter, Bishop wastes no time in addressing the primary objection usually raised against emergence, namely "the belief in the *causal closure of fundamental physics* (CCFP)." In other words, knowing only the elementary laws of nature and the initial conditions, the subsequent evolution of any system over time can be determined. No contextual or external factors are needed. The universe is thought to be fully explained by "bottom-up" factors. Bishop points out that there are two basic assumptions in this objection:

> **Atomism**: *Law-like regularities of macrostates are fully determined by the law-like regularities and micro features of microstates in all cases regardless of context.*
>
> **Context freedom**: *All features of macro contexts are fully determined by context-free features of the underlying law-like features of microstates*. (chapter–page, 2–5)

The rest of the book is a thorough refutation of the CCFP and related objections to emergence. Chapter three is devoted to showing specifically how factors that cannot be derived solely from fundamental laws are necessary for understanding complex phenomena. Chapter four presents several case studies illustrating the need for higher level contexts in physics. One of the examples he describes is the very concept of temperature which depends on stability conditions that are not often articulated in statistical mechanics.

In chapter five, Bishop returns to the objections to contextual emergence he earlier listed in chapter two and convincingly dispenses with them, arguing that, without contextual information, the fundamental laws are inadequate for explaining the world around us. Finally, Bishop concludes with chapter six, in which he discusses the broader implications of contextual emergence. In biology, for example, collective interactions of large ensembles of microbes, cells, or biomolecules set the contextual conditions for novel structures to emerge.

Though the book is short, it is decidedly not a casual fireside read. A solid grounding in theoretical physics and philosophy is helpful in following the key arguments and examples. Nevertheless, going beyond the details of his argument to the big picture, Bishop has provided us with a powerful, seminal work. He has given us a compelling refutation of the reigning perspective of reductionism, together with a rich new paradigm of contextual emergence for a path forward in understanding our universe.

As he explains, the laws of nature provide a necessary but not sufficient set of conditions for behavior and properties at a larger scale. The specific context of an application of those laws provides additional necessary and sufficient conditions for the behavior of that system. That is, the characteristics we observe at a larger scale emerge from the laws of nature operating in a specific context that is related to but not derivable from the fundamental laws.

Another important implication relates to the understanding of determinism and free will. Bishop shows how the laws of nature in and of themselves are neither deterministic nor indeterministic. Rather, "… contextual emergence makes explicit that determinism and indeterminism are contextually-emergent

features of our world as opposed to an absolute feature of the Universe" (chapter–page, 6–17). In some contexts, the laws of nature, such as the Newtonian laws of motion, lead to systems that are deterministic while in other contexts they do not. Thus, "determinism is a contextual feature of reality" (chapter–page, 6–11).

Finally, dualism is not required to explain complex phenomena that cannot be derived solely from fundamental laws. Rather, the conditions that emerge from the interaction of an ensemble of components provide the contexts in which the lawful behavior of nature produces those phenomena. Contextual emergence recognizes the top-down conditions that influence the bottom-up work of the laws of nature. Those conditions are not independent of but are related to the fundamental laws and particles of which the system is composed.

Bishop has laid the philosophical foundation in physics for the rich concept of contextual emergence. It is likely to bear much fruit in the future as it is applied to all the domains such as biology and sociology in which we describe our universe.

*Reviewed by Randy Isaac, ASA Executive Director Emeritus, Topsfield, MA 01983.* ♥

# Letters

## Doubting Miller's Doubt

Keith Miller's article "Doubt and Faith in Science and Religion" (*PSCF* 70, no. 2 [2018]: 90–100) is informative, well written, and realistic. The author is well versed in the subject of science and religion. Unfortunately, I do have a problem with the basic concept of his article which is that "scientific inquiry and religion are founded on the acceptance of fundamentally unprovable assumptions." However, many actual observations and actual experiences are not based on assumptions at all.

The following simple scientific inquiry is a typical example: I hold an object in my hand. I want to know if it floats in water. In order to find out I have to perform an experiment. I place the item in a pail filled with water. I observe that it sinks. My knowledge of the universe has been increased by performing this experiment. I now know that the item sinks in water. There is no doubt in the result of this experiment. This scientific inquiry was not founded on basic assumptions because it did not use any assumptions at all.

Scientific knowledge and religious knowledge based on actual observation and/or experience are not founded on assumptions and are therefore not subject to correction and change. Their explanations may be founded on unprovable assumptions and may be subject to correction and change.

Martin Huizinga
ASA Member

## Miller Replies

In his letter responding to my article "Doubt and Faith in Science and Religion" (*PSCF* 70, no. 2 [2018]: 90–100), Martin Huizinga argues that many actual observations and experiences are not contingent on any assumptions. However, this comment illustrates one of the primary points that I made in the article. That is, there are fundamental unprovable assumptions that underlie all knowledge. These assumptions are often held without any conscious awareness. In using observations to construct our understanding of the natural world, we depend on the assumption that our senses provide true information about an external physical reality. In fact, we must assume that an objective physical reality that is accessible to us even exists. This is not trivial.

The equivalent in the pursuit of religious truth, is the assumption that there is a "supernatural" reality. For Christians, that assumption includes the existence of a personal transcendent creator God who is also immanent in the natural world. All our subsequent knowledge must start there.

Keith B. Miller
ASA Fellow ♥

## *Perspectives on Science and Christian Faith* Three-Year Index

The three-year *PSCF* index will no longer be published in the journal. The last one was published in the December 2016 issue. An index for each issue is available online by clicking on "Dynamic directory of *PSCF* articles and tables of contents" found at https://network.asa3.org/page/PSCF?.