If evaluated as a work of fiction, it would be safe to say that *Dawn* is wildly imaginative, yet it is also strangely hindered by the passivity of the narrating subatomic particles. "Imagine that you yourself could determine where you would like to go" (p. 28), they muse just before the first protocell develops. Pro witnesses and experiences history but cannot intervene. The subatomic particles can react, but they have no agency in the macroscopic world. They do not embark on a quest or a voyage of self-discovery. "Just go with the flow" (p. 29), one advises. The tropes of fiction, however, are probably the wrong standards for evaluating this book.

*Dawn* succeeds, in the end, as creative nonfiction—the memoir of a proton. Along the way, it retells the old, old story in an imaginative way. The authors have created one of the most accessible books on science and Christianity to come out in recent years. Even young adults will be able to enjoy it.

Note

[1]Cees Dekker, distinguished nano-scientist at Delft University of Technology; Corien Oranje, novelist/theologian and author of Christian children's literature; and Gijsbert van den Brink, theologian and holder of the Chair of Theology and Science, Vrije Universiteit Amsterdam.

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**FRACTALS: The Secret Code of Creation** by Jason Lisle. Green Forest, AR: Master Books, 2021. 224 pages. Paperback; $29.99. ISBN: 9781683442400.

*Fractals: The Secret Code of Creation*, by Jason Lisle, is a beautifully crafted coffee-table book which invites readers not only to the beauty of mathematics, but also to belief in Christianity. The author is affiliated with Answers in Genesis and is a founder of the Bible Science Institute, both of which insist on a young earth interpretation of Genesis 1–3.

The mathematical chapters are well written, but the book is really an apologetic for a narrow Christian worldview. The book claims that mathematics, particularly the Mandelbrot fractal and similar objects, displays God's nature. The first chapter, "The Secret Code," claims that "those who reject God like to explain the complexity of biological life by appealing to Darwinian evolution," but that mathematics is free from this "because numbers do not evolve." The fractals in this book, beginning with the Mandelbrot set, give an "infinitesimal glimpse into the mind of God" (p. 9). This sets the theme: there are only two worldviews, and these are in direct competition. The mathematics of fractals is to lead the reader toward the Christian worldview, indeed to a "secret code."

A computer-generated example of a fractal, introduced by Benoit Mandelbrot,[1] is created in the complex plane by iterating the quadratic function $f(x)=x^2+c$. Pick a complex number c and examine the sequence $c$, $f(c)$, $f(f(c))$, and so on. Ask the question, "Do these iterates of the function form a bounded sequence?" If the sequence is bounded, then the complex number $c$ is in the Mandelbrot set. In the complex plane, color that point, $c$, black. If the sequence $c$, $f(c)$, $f(f(c))$, … is *not* bounded, give $c$ a color based on the speed of growth of the sequence. Use a modern computer to color the points in the complex plane. With this coloring, the mathematical analysis of the Mandelbrot set gives rise to intricate paintings of the complex plane.

After this introduction, the book describes the required mathematical material: sets, complex numbers, function iteration. The mathematical descriptions are well done and intended for a popular audience. There are no frightening equations to drive away the reader. The prose, along with the accompanying artwork, is inviting. One might use much of this book as an invitation into the study of mathematics. Indeed, many mathematicians have used the study of fractals to do just that.

Chapters two through seven explore the mathematics of the Mandelbrot set with text-printed elegant pictures of various regions of the fractals. Chapters two through five, with picturesque titles—"Valley of the Seahorses," "Valley of the Double Spirals," "Infinite Elephants, Scepters on Seahorses"—focus on a particular region of the Mandelbrot set, zooming in to display intricate spirals, bays, peninsulas. The infinite complexity of these drawings is beautiful and agrees with my belief that mathematics is the language of the great artist.

The sixth chapter, "Changing the Formula," asks what happens if the simple quadratic $f(x)=x^2+c$ is replaced by other quadratics. It is shown, by examples, that other quadratics merely transform the Mandelbrot set, shifting it in some obvious manner. A mathematics student comfortable with function transformations will recognize that any quadratic function can be transformed into any other quadratic—this is the essence of the quadratic formula—and so it should not be surprising that nothing new is achieved by replacing one quadratic by another.

Later chapters replace a quadratic function by other polynomials, then by functions involving fractional exponents, then by a conjugate function and finally by trigonometric and exponential functions. Euler's marvelous identity $e^{i\theta}=cos\theta+i\,sin\theta$ briefly comes into play, linking trigonometric and exponential functions in the complex plane. In all these chapters, the mathematical explanations are kept simple, and the beautiful artwork continues. The chapter, "Geometric and 3D Fractals,"

asks about higher dimensional figures and introduces the quaternions. The chapter does not go deeply into the material but intends to leave the reader curious and intrigued. The concluding chapter describes occurrences of fractals as physical objects in nature (shorelines, clouds, trees, etc.), returning to the topic found in Mandelbrot's introductory book.

Chapter 8, "Fractals and the Christian Worldview," is an interlude to the mathematics, returning to the claim that of the two suppositions, a Christian or a non-Christian worldview, only the Christian worldview truly explains fractals. Yes, the infinite complexity of the Mandelbrot set is beautiful. Many mathematicians agree that beautiful objects like this are independent of human thought, a form of mathematical *platonism*. But the leap from mathematical *platonism* to belief in a creator and then to belief in the biblical God is not well supported by Lisle. He ignores the difficulties involved in these steps: first from mathematical *platonism* to deism, and then from deism to belief in the God that Christians worship.

In the final (twelfth) chapter, Lisle returns to his argument that mathematics points to the God of the Bible. He quotes physicist Eugene Wigner's article, "The Unreasonable Effectiveness of Mathematics in the Natural Sciences," which discusses the "miracle" of mathematics in explaining the modern world.[2] Lisle then quickly dismisses other religious views and claims that only the Bible makes sense of our universe. The book ends with a gospel presentation.

One can argue (Rom. 1:20) that God's divine nature is visible in the beauty of mathematics, but Lisle quickly dismisses the beliefs of atheists and non-Christian religions and leaps to claiming (as implied by the book's subtitle) that the *only* legitimate reaction to fractals is to believe in the Christian God. While most of my mathematical colleagues identify with mathematical *platonism*, their beliefs vary across a spectrum from atheism/agnosticism through Judaism, Islam, and Christianity. The jarring leap from "the beauty of fractals comes not from people" (p. 125) to the Christian worldview, will leave a thoughtful skeptic with whiplash. At no place is the "secret code" to creation explained explicitly.

Lisle's approach to apologetics is that of presuppositionalism. He assumes that only a Christian worldview is reasonable. However, presuppositional apologetics has several significant flaws. It can quickly become a circular argument: if one assumes the truth and accuracy of the Bible as an axiom then the Christian worldview is a foregone conclusion. This approach receives quick approval from people who already believe the scriptures but is readily dismissed by the sceptic. Even when the circular argument is avoided, the best one can argue is that the universe—and mathematics—appears to be beautiful, appears to have design. The appearance of design is roughly equivalent to mathematical *platonism* and parallels the argument of Romans 1. But the sceptic who accepts this argument will immediately point out that there are many worldviews that begin with this assumption. The leap to the Christian worldview is not proven by this approach; it requires the additional confirmation of special revelation.

In other publications, Lisle rejects both the big bang theory and evolution. Ironically, this beautiful book on fractals makes it clear that elegant and complex structures do indeed arise from quite simple processes. This is a concept that underlies the theory of evolution, which Lisle opposes.

Would I put this book on my coffee table? No, because ultimately this book is an attempt at apologetics. The flaw in the apologetics will be apparent to the thoughtful sceptic. And the author's attempt to establish the Christian worldview includes simplistic claims that are dismissive of people with other beliefs.

Notes

[1]Benoit B. Mandelbrot, *The Fractal Geometry of Nature* (New York: W. H. Freeman, 1982).

[2]E. P. Wigner, "The Unreasonable Effectiveness of Mathematics in the Natural Sciences," *Communications on Pure and Applied Mathematics* 13 (1960): 1–14.

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## History of Science

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**GENERATIONS OF REASON: A Family's Search for Meaning in Post-Newtonian England** by Joan L. Richards. New Haven, CT: Yale University Press, 2021. 456 pages, with 21 b/w illustrations, 1,218 endnotes, and a 35-page index. Hardcover; $45.00. ISBN: 9780300255492.

The title gives no clue who this book is about. Nor does the publisher's description on its website, the abbreviated blurb inside the book jacket, the four endorsements posted on the jacket's back ("beautifully written," "epic masterpiece," "magnificent study," "compelling and wide-ranging"), or even the chapter titles. The reader first learns whom the book is about and how it came into focus in the author's Acknowledgments. In studying the divergent interests of Augustus De Morgan and his wife, Sophia, the importance of De Morgan's father-in-law William Frend's thinking became apparent. This is turn led Richards to delve into the lives and beliefs of two ancestors from the previous generation, Francis Blackburne and Theophilus Lindsey, who felt compelled by their commitment to "reasoned conclusions about