

The allure of the aesthetic

A Beautiful Question Finding Nature's Deep Design

Frank Wilczek
Penguin Press, 2015. \$29.95
(430 pp.). ISBN 978-1-59420-526-2

Reviewed by Sabine Hossenfelder

My four-year-old daughter recently discovered that equilateral triangles combine to form larger equilateral triangles. When I caught a distracted glimpse of her artwork, I thought she had drawn the baryon decuplet, an often-used diagram to depict relations between some of the particles composed of three quarks.

The baryon decuplet doesn't come easy to humans, but the beauty of symmetry does. And how amazing it is that physicists have found symmetry tightly woven into the fabric of nature itself: Both the standard model of particle physics and general relativity, currently our most fundamental theories, are in essence mathematically precise implementations of symmetry requirements.

Next to being instrumental for the accurate description of nature, symmetries are also universally appealing to humans, as reflected in art and design across cultures. For the physicist, it is second nature to see the equations behind the art. Indeed, having that ability may be considered either a curse or a blessing.

To Frank Wilczek, it clearly is a blessing. In *A Beautiful Question: Finding Nature's Deep Design* he highlights the success of symmetries in physics and goes on to answer the question of whether "the world embodies beautiful ideas" with an emphatic "Yes." Wilczek starts from the discovery of basic mathematical relationships like Pythagoras's theorem (and doesn't shy away from proving it!) and proceeds through the history of physics, stopping to consider such milestone topics as musical harmonies, the nature of light and the basics of optics, Newtonian gravity and

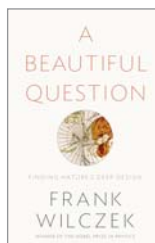
its extension to general relativity, quantum mechanics, and ultimately the standard model of particle physics. He touches briefly on condensed-matter physics—graphene in particular—and takes an interesting detour into the human eye's limited ability to decode visual information.

In the last chapters of the book, Wilczek goes into quite some detail about the particle content of the standard model and how, it seems, the model is not as beautiful as one may have hoped. He introduces the reader to extended theories such as grand unification and also supersymmetry, which was invented to remedy some of the supposed shortcomings of the standard model. The reader unfamiliar with the quantum numbers used to classify elementary particles will likely find some parts of that section a bit demanding.

But whether or not one makes the effort to follow the details, Wilczek gets his message across clearly: Striving for beauty in natural law has been a useful guide, and he expects it to remain one. He is, however, careful to note that relying on beauty has, on various occasions, led to plainly wrong theories, such as an explanation of planetary orbits in terms of Platonic solids or a theory of atoms based on the mathematics of knots.

A Beautiful Question is a skillfully written reflection, or "meditation," as Wilczek puts it. It is well structured and accompanied by many figures, including two inserts with color prints. The book also contains an extensive glossary, recommendations for further reading, and a timeline of discoveries mentioned in the text.

The content of the book is unique in the genre of popular works. Dave Goldberg's *The Universe in the Rearview Mirror: How Hidden Symmetries Shape Reality* (Dutton, 2013), for example, also discusses the role of symmetries in fundamental physics, but Wilczek gives more space to the connection between aesthetics in art and science. *A Beautiful Question* picks up and expands on the theme of Steven Weinberg's book, *Dreams of a Final Theory* (Pantheon, 1992), which also expounds on the relevance of beauty in the development of



physical theories. More than 20 years have passed since Weinberg wrote his book, but the dream is still as elusive today as it was back then.

For all its elaboration on the beauty of symmetry, Wilczek's book falls short of spelling out a conundrum physicists face

today: We have no reason to be confident that the laws of nature yet to be discovered will conform to the human sense of beauty. Nor does Wilczek spend many words on aspects of beauty beyond symmetry; he only briefly touches on fractals, and never goes into the rich appeal of chaos and complexity.

My mother used to say that "symmetry is the art of the dumb," a criticism perhaps too harsh to level at the standard model. But seeing that reliance on beauty has not helped us in the past two decades, maybe it is time to consider that a beautiful answer might not reveal itself as effortlessly as does the appeal of plane tilings to a four-year-old. Maybe the inevitable subjectivity in our sense of aesthetic appeal will turn out to be a curse, misleading us as to where the answers lie.

Wilczek's book contains something for every reader, from the physicist who wants to learn how a Nobel Prize winner thinks of the connection between ideas and reality to the layman who wants to know more about the structure of fundamental laws. *A Beautiful Question* reminds us of the many ways that science connects to the arts, and it invites us to marvel at the success our species has had in unraveling the mysteries of nature.

Nonlinear Physics of Ecosystems

Ehud Meron
CRC Press, 2015. \$89.95 (344 pp.).
ISBN 978-1-4398-2631-7

Many concepts and methods from nonlinear physics have proved to be useful for addressing important problems in ecology. Indeed, a growing number of physicists are working with ecologists and are making significant contributions to ecology. Pattern formation and spatial ecology—how those patterns are related to ecological phenomena—are particular research areas that benefit

Sabine Hossenfelder is an assistant professor of high-energy physics at Nordita, the Nordic Institute for Theoretical Physics, in Stockholm. She works on physics beyond the standard model and on quantum-gravity phenomenology, and she blogs at <http://backreaction.blogspot.com>.