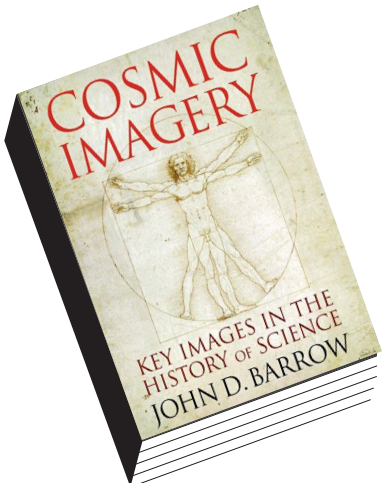

Cosmic Imagery:
Key Images in the History of Science
By John D. Barrow
The Bodley Head
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John Barrow, a cosmologist at the University of Cambridge and author of many highly acclaimed books, has given us a richly illustrated volume. It is a celebration of the central role visual images have played in the development of science. The images he discusses span the millennia from the square root of two, calculated by the Babylonians in 1700BC and literally etched in stone, to snowflakes, graphs, anatomical drawings, maps, including the London Underground map and Cantor's diagonal methods for counting infinities.

Among the iconic images he includes are Leonardo da Vinci's *Vitruvian Man*, the sun-centred solar system of Nicolaus Copernicus, DNA – "the molecule of the millennium" – and the mushroom cloud from a nuclear explosion.

Most interesting for me are certain visual images that have played a key role in creative scientific thinking. Barrow explores how the visual representation of data – numbers – enables scientists to find patterns that provide insights into formulating a theory that explains them. The periodic table of the chemical elements, developed in the 1860s by Dmitri Mendeleev, brought order to the many known elements. But it also permitted predictions of new ones in addition to serving as a fundamental problem that any theory of the atom had to confront. Fifty years later,

"Visual images provide a touchstone. Without them scientists feel lost, adrift in an infinite cosmos"

Wolfgang Pauli's Exclusion Principle finally provided an explanation for its structure.

Visual images provide a touchstone. Without them scientists feel lost, adrift in an infinite cosmos. This was the case in quantum physics in the 1920s when the iconic imagery of Bohr's atom as a solar system had to be abandoned. Then in 1949 Richard Feynman "introduced a new pictorial way of thinking". Feynman diagrams are a way of visualising the counterintuitive world of the atom described in quantum physics. Physicists often "think" in terms of Feynman diagrams. They are more than just a tool for calculations.

Barrow delves into stunning cases of the power of visual thinking in scientific discovery. When Francis Crick and James Watson, in 1953, discovered the helical structure of DNA, they imagined what data represented on two-dimensional photographic plates would look like in three dimensions. Barrow tells how, in 1985, the chemist Harry Kroto figured out that the structure of the molecule carbon 60 (C^{60}), with its 60 carbon atoms, is like a football made up of hexagons and pentagons, a "Buckminsterfullerene" as Kroto called it. Kroto's earlier interest in architectural and graphic design proved essential to his thinking.

The dramatic images we see of the universe are essential for astrophysics research. Barrow shows us the iconic Eagle Nebula, a star nursery 7,000 light years away. But we have to remember that these images are computer simulations: vast arrays of numbers, in this case gathered up by the Hubble Space Telescope, turned into visual images of shapes we cannot see, huge structures as invisible to us as submicroscopic atoms.

The role of visual thinking in scientific research is crucial, as Barrow's quote from Feynman aptly shows. "Einstein's great work had sprung from physical intuition, and when Einstein stopped creating it was because he stopped thinking in concrete visual images and became a manipulator of equations."

Barrow has succeeded in producing a superb book on a complex and important subject, understandable to the lay public and engaging to scientists. No mean feat.

Arthur I. Miller is emeritus professor of history and philosophy of science, University College London. His latest book, *Equations of the Soul: Jung, Pauli and the Quest for the Cosmic Number,* will be published in April 2009.
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