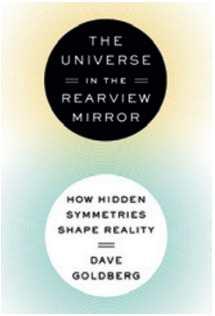
The Milky Way: An Insider's Guide is clearly designed as a follow-up, and updated version, of the classic book *The Milky Way* by Bart Bok. Books of this sort play an important role in the fundamental literature, as they are often among the very first such books taken up by young students who may go on to become the professionals of the future. For this reason, it is crucial to capture not only the collective knowledge at a given point in time, but to look forward towards the influence that future observations and models will have on the subject. It is a fine line, which Waller walks well. Still, I found myself wanting even more information on the impact of modern surveys — such as the galactic programs carried out by the Sloan Digital Sky Survey (SDSS) — which have contributed an enormous amount of detail to the modern understanding of the Milky Way and its constituent objects. Examples include the discovery of debris streams of stars associated with the stripping of individual dwarf galaxies as they are assimilated into the halo of our Galaxy, the ultra-faint dwarf spheroidal galaxies that may well be the surviving examples of the building blocks of the halo system of the Milky Way and the chemistry of the early Universe written in the atmospheres of the metal-poor stars it comprises. Of course, much of this knowledge is still in the process of being acquired, so perhaps we can look forward to a bit more 'spice' in the mix of future editions of this book.

Waller's book provides an excellent starting point, telling the story of the formation and evolution of the Milky Way, and how this hard-won knowledge was obtained — and it does so in an entertaining and not overly detailed fashion. It should be among the first recommendations to new students of the field, as well as to citizen scientists who wish to deepen their understanding of one of the fundamental, as well as fast-advancing, areas of modern astronomy. ❐

REVIEWED BY TIMOTHY C. BEERS
Timothy C. Beers is at the Kitt Peak National Observatory, Tucson, Arizona 85719, USA.
e-mail: beers@noao.edu

Symmetry on centre stage



The Universe in the Rearview Mirror: How Hidden Symmetries Shape Reality

By Dave Goldberg

DUTTON BOOKS: 2013. 336PP. $27.95

There is no doubt that symmetry has been one of the most fundamental and fruitful concepts in our attempts to decipher the inner workings of the Universe. If it were not for the symmetries from which universal laws of nature stem, we would have had no hope of ever figuring out the grand cosmic design. For instance, if the laws of physics were not symmetric under translation (namely, if they changed from location to location), experiments would have had to be repeated at every point, making a comprehensive theory (and probably life itself) impossible. In his fast-paced, enjoyable journey from the subatomic world to the 'multiverse', Dave Goldberg explains a vast array of symmetries and their implications. He starts with those symmetries that are associated with changes in our viewpoint in space and time (such as rotations, reflections and Lorentz invariance), passes through discrete symmetries (for example, charge conjugation and parity) and finishes with internal (gauge) symmetries that concern our perspective on the identity of elementary particles or on the phase of wavefunctions (such as those represented by the mathematical groups U(1), SU(2), SU(3), as well as supersymmetry). Along the way, Goldberg discusses a wide range of topics, such as the excess of matter over antimatter in our Universe, the nature of time and its relation to the second law of thermodynamics, special and general relativity, the concepts of quantum mechanical spin and entanglement, and the recently discovered Higgs boson and its role in endowing elementary particles with mass. All of this is done with great humour, employing relatively simple, easy-to-understand analogies.

Goldberg's style is engaging, and he doesn't hesitate to admit at certain points that the subject is intricate, or that even the scientists don't know the answers to many questions. He also confesses that the professional language (for instance, group theory) used to classify symmetries is intimidating. Appropriately, in the more challenging parts of the book, he basically asks the uninitiated readers to bear with him and wait until he is able to provide further expositions and clarifications.

The book's main strength lies in its placement of symmetry on centre stage. Unlike many other books covering similar topics, in which symmetry appears almost as a sidebar or an afterthought, Goldberg goes out of his way to clearly convey the message that symmetry is the source of all the laws of physics. Furthermore, he stresses the fact that, on its largest scales, the Universe itself is homogeneous (the same at every point) and isotropic (looks the same in every direction). This manifestation of the so-called 'cosmological principle' expresses a cosmic symmetry under translations and rotations — the same type of symmetries that, when applied to the physical laws, underlie the reality that certain quantities (momentum and angular momentum, for example) are conserved.

There was only one element that slightly bothered me in this book — as a matter of personal taste — and that was the order in which certain subjects are presented. In particular, highly speculative ideas (such as the potential existence of a multiverse), are presented before certain well-established theories and concepts (special and general relativity and quantum mechanics, for instance) make their first appearance. This not only distorts the chronological order from a history of science perspective, but it also fails to provide the logical sequence of physical motivations (for example, the multiverse was inspired by inflation and string theory, both of which ultimately sprang from relativity and quantum mechanics). In spite of this small perceived shortcoming, however, *The Universe in the Rearview Mirror* makes for a great read for anyone interested in understanding what it is that makes our Universe a wonderfully complex system. Whether looking forward through the windshield, or backward in the rear-view mirror, Goldberg is an excellent guide to bring you to your destination — to a profound appreciation for the beauty of the cosmos. ❐

REVIEWED BY MARIO LIVIO
Mario Livio is at the Space Telescope Science Institute, Baltimore, MD 21218, USA. His most recent book is entitled Brilliant Blunders (Simon & Schuster; 2013).
e-mail: mlivio@stsci.edu