

and wondrous ways to exploit physical effects. As Daniel Dennett observed in *Darwin's Dangerous Idea: Evolution and the Meanings of Life* (Simon and Schuster, 1995), natural selection has explored more of "design space" than humans are likely to get to in the near future. Biology is particularly adept at highlighting the obscure but useful among physical phenomena.

Ahlborn has chosen to restrict his attention to a macroscopic, largely Newtonian world that spans classical mechanics, thermodynamics, and wave phenomena (light and sound), the context in which most of the familiar plants and animals evolved. Unfortunately, his treatment is largely one of a physicist looking at biology rather than explicating it. Numerous models of biological phenomena are derived from basic physics, but rarely are they compared with actual biological data. I was surprised that the presentation of aerodynamic lift lacked any mention of circulation, much less the clever ways animals augment circulation to increase instantaneous lift. The description of osmosis is also inaccurate. For a book of this size, the reference section is tiny (four pages), and many of the citations are to secondary sources such as *Scientific American*, *Discover*, and *PHYSICS TODAY*, rather than to the primary literature.

Although the physics presented is generally sound, the biology is not to be trusted, and a naive physics major could be led badly astray. What is called the cell wall throughout the book is actually the cell membrane, "gates" are ion channels, and what is called co-evolution is actually evolutionary convergence, a very different phenomenon. The following examples illustrate the spectrum of misstatements I found in the book: the collagen fibers in a nematode cuticle are not muscles (page 101); pterodactyls were not birds (page 122); capillaries are not polished by red blood cells (page 146); dogs cannot retract their claws (page 199); IR is not a useful way for snakes to find worms (page 265), which are at the same temperature as their surroundings; the magnetic sense of pigeons and honeybees is not due to symbiotic bacteria (page 381); and bacteria do not extract metabolic energy from the heat of deep sea vents (page 405).

Some of Ahlborn's misstatements may be due to poor writing, but some clearly imply lack of scholarship. For example, the flat statement that insects "can never be homeotherms" is contradicted by 50 years of careful

work (reported in virtually every textbook on animal physiology) on the thermal biology of bees, moths, and beetles. Most distressing to the biologist, however, is Ahlborn's apparent misunderstanding of both the evolutionary process and evolutionary history. The book repeatedly speaks of animals "learning" to do some function in the evolutionary process; natural selection is virtually invisible in this volume. Progressive evolution and a *scala natura* (for example, mammals are "better" than reptiles) are not only assumed, they become explicit elements in some of the arguments presented. The true richness and contingent nature of evolutionary biology is lost in Ahlborn's book, and it is significantly poorer because of that loss.

The publisher should be chided for the clear lack of any editorial investment. Reviewers would have caught most of the worst mistakes, but there is no evidence that the manuscript was ever sent out for review. It would appear that it was never even copyedited: Abbreviations in the text often disagree with those in the figures and in the lists at the ends of chapters; "physics" and "zoology" are treated as proper nouns; commas are scattered at random; and paragraph breaks occur with no apparent logic. Had the text been run through a spell checker, gems like "blue wale," "yelly fish," "throtteling," and "platybus" would not be so common. In the second half of the book, presentations become highly repetitive, with nearly identical arguments offered within a few pages of each other. References cited in the text often do not appear in the "References" section, and about 10% of the citations that do appear in the section are incorrect.

Sadly, what could have been a unique and useful addition to the literature on the interface between biology and physics is rendered nearly useless by the publisher's neglect. For someone interested in intelligent introductions to the topic, Howard Berg's charming *Random Walks in Biology* (Princeton U. Press, 1983), which was expanded in 1993; Mark Denny's *Air and Water: The Biology and Physics of Life's Media* (Princeton U. Press, 1993); Steven Vogel's *Cat's Paws and Catapults: Mechanical Worlds of Nature and People* (W. W. Norton, 1998); and his *Comparative Biomechanics: Life's Physical World* (Princeton U. Press, 2003) would be better investments of time.

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A Concise History of Solar and Stellar Physics

Jean-Louis Tassoul and Monique Tassoul
Princeton U. Press, Princeton, NJ,
2004. \$39.95 (282 pp.). ISBN 0-691-11711-X

Awareness of a scientific subfield's history and principal players is disappearing from the minds of today's researchers. In *A Concise History of Solar and Stellar Physics*, husband-and-wife team Jean-Louis and Monique Tassoul, both theoretical astrophysicists, wanted to rectify this troubling development for solar and stellar physics, disciplines broad enough to embrace such diverse fields as nuclear fusion and magnetohydrodynamics. The authors' historical journey spans nearly three millennia—from astronomy in ancient Greece and the Middle East to the 21st century.

The Tassouls' theoretical point of view works naturally for the earlier part of the book, which covers the days long before Galileo turned his telescope to the skies, when all observational astronomy relied on people's keen eyesight. The opening chapter on ancient astronomical ideas is marvelously written—the best I have read on the subject for many years. The authors present a real sense of the role of accidents in history, such as how Aristarchus's heliocentric universe was overshadowed by Aristotle's theory of a geocentric universe; that accident led to the Catholic Church's uncompromising acceptance of the notion that Earth was at the center of everything. European astronomy was shaped by this belief until the time of Copernicus. The full account of Babylonian contributions to astronomy, and the little-known names of people associated with them, was gratifying for me and balanced out the European contributions also mentioned in the book.

The authors' theoretical stance continues to make sense for later chapters in which they recount the period in the early 20th century, when astronomers were still groping for a satisfactory explanation of why the Sun shines, what its structure is, or whether blue stars evolve into red stars. Some surprises are in store: Who would have guessed that the conservation of energy was dis-



covered not by a physicist but by a naval surgeon, Julius Robert Mayer, who was examining the blood of European sailors? Or that it was neither Herman Helmholtz nor Lord Kelvin who first thought of gravitational contraction as a mechanism to explain the Sun's heat but was instead an obscure Scottish physicist named John Waterston, who had several papers rejected for publication? *A Concise History of Solar and Stellar Physics* does much to rescue such discoverers from oblivion and restore them to their rightful place in the canon of the history of astronomy.

Taking on the history of solar and stellar astronomy from 1900 onward is a mammoth task, and it is perhaps inevitable that the book has notable gaps and an obvious lack of emphasis on astronomical observations. For example, a single page is devoted to solar flares, with the barest mention (in a footnote) given to theories of how magnetic energy is converted to heat and particle acceleration. No mention is made of stellar flares, despite the topic's venerable history, which dates to Bernard Lovell's observations at Jodrell Bank Observatory in England. Readers will search in vain for many of the discoveries made by spacecraft. I found the omitted elucidation of the connection between fast solar wind

streams and coronal holes derived from *Skylab* observations particularly distressing.

A historian's view of a "golden age" is necessarily subjective. For the Tasouls, that age was 1940 through 1970. Was it so golden? To be sure, a great many discoveries, ranging from stellar population types—from Walter Baade's work on globular clusters as he observed Los Angeles's wartime-darkened skies—to pulsars were made during that period. But such discoveries continued well into the 1970s and beyond, with, for example, the dramatically improved understanding of solar and stellar coronae obtained from measurements with spacecraft instruments. Yet the Tasouls label the period from 1970 onward as the "Age of Specialization," when no epoch-making monographs were written but only masses of multiauthored papers. Their take on that age is either pessimistic or realistic, depending on one's point of view.

An attractive feature is the collection of portraits of many leading—and some lesser-known—astronomers, with short biographies that will delight many readers. The line drawings adequately illustrate points made in the text and are clear rather than elaborate. Like any good historical account,

the book contains lavish, informative footnotes with up-to-date references. However, I question the need for many of the book's several appendixes.

A Concise History of Solar and Stellar Physics is clearly not aimed at a general audience. Nonspecialists will be put off by some of the very detailed accounts, such as models of solar and stellar interiors. Yet the broad sweep of subjects that are covered will make the book useful to physics and astronomy undergraduates and others who wish to delve into the subject's past and improve their scientific literacy.

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Structured Fluids: Polymers, Colloids, Surfactants

Thomas A. Witten (with Philip A. Pincus)

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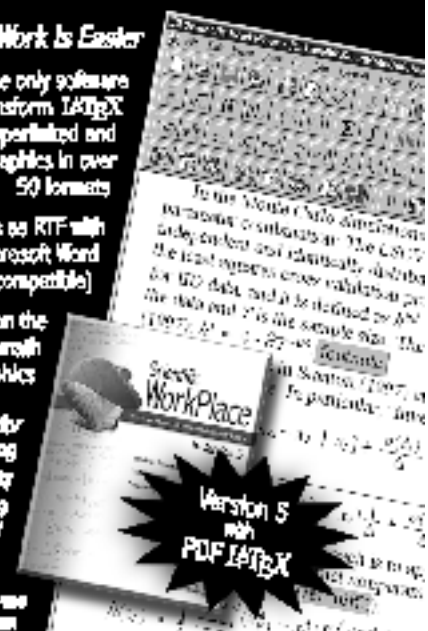
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