

Strokes of Genius Behind the Canvas

Math and the Mona Lisa: The Art and Science of Leonardo da Vinci

Bülent Atalay
Smithsonian Books, Washington, DC, 2004. \$24.95 (314 pp.). ISBN 1-58834-171-2

Reviewed by Alan E. Shapiro

In *Math and the Mona Lisa: The Art and Science of Leonardo da Vinci*,



physicist and artist Bülent Atalay aims to bridge the gap that divides two cultures. To achieve the desired conciliation of art and science, he takes da Vinci, the archetypal Renaissance man, as his prime example of some-

one who truly bridged science and art, and he tries to apply to our era the lessons learned from the great master.

The scope of *Math and the Mona Lisa* is broad. Besides studying da Vinci's art and science, Atalay examines creativity and the nature of art and science and surveys the entire history of the mathematical sciences. The central theme of the book, though, is the place of mathematics in art, science, and nature. That theme is developed in two largely independent ways: first, by presenting the role mathematics plays in art and second, through the familiar story of the mathematization of nature by physicists. The first line of development is more original and is pursued by Atalay because he believes the confluence of art and science is found in the common, quantifiable, and mathematical grounds of the two cultures. He discusses mathematical aspects of art,

such as symmetry, proportion, and perspective. But what most fascinates him is the "divine" or "golden" proportion in which a magnitude has been divided so that the ratio of the whole magnitude to the larger part equals the ratio of the larger part to the smaller part.

Throughout his book, Atalay shows how that proportion manifests itself in art by examining numerous paintings (by da Vinci, Diego Velázquez, Georges Seurat, and Marc Chagall, for example), the great pyramids of Egypt, the facade of Notre Dame cathedral, and much more. He even presents psychological evidence that people have an intrinsic preference for the golden rectangle over other rectangles and prefer faces that obey the golden proportion. To me, such an argument appears to be numerology, with its apparently arbitrary choice of points and placement of lines—the world of Dan Brown's *The Da Vinci Code* (Doubleday, 2003). But whenever I was about to lose my patience with the book, Atalay disarmingly assured the reader that artists' use of the divine proportion is, for the most part, unconscious and concedes that a concern for the golden ratio can be taken too far.

Yet da Vinci is one of those artists Atalay justifiably believes may have consciously used the divine proportion in his art: He executed many elegant drawings of polyhedra for an important book of the same name, *De divina proportione*, which was written in 1509 by his friend, the mathematician Luca Pacioli. Atalay proposes that Renaissance artists, with their concern for direct observation of nature and their integration of art, science, and engineering, helped to launch modern science.

Although I believe that he overemphasizes da Vinci's significance and originality as a scientist and engineer—as many do—his assessment of the role Renaissance artist-engineers played in launching modern science is on the mark. Unfortunately, much of the rest of Atalay's history of science, which carries the burden of his second major line of development—scientists' mathematization of nature—falls far wide of the mark. For example, he

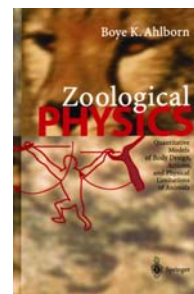
tells us that the medieval Arabic contributions to optics were unsurpassed until the work of Isaac Newton and Christiaan Huygens in the late 17th century, but he ignores the seminal contributions made earlier in the century by Johannes Kepler, who introduced the modern theory of vision and demonstrated that an inverted image is formed on the retina. In another example out of very many, Atalay repeats the canard that Kepler stole Tycho Brahe's data: On the contrary, Kepler had legal title to it.

While much of *Math and the Mona Lisa* is entertaining, it fails to bridge the two cultures of science and the humanities. Despite the presence of mathematics in some aspects of artistic works, humanists—and probably most scientists—will not be convinced that mathematics is an essential feature of art. Whatever the true nature of art may be, mathematics appears to be only incidental to it, both as a means of analysis and as a tool.

Zoological Physics: Quantitative Models of Body Design, Actions, and Physical Limitations of Animals

Boye K. Ahlborn
Springer-Verlag, New York, 2004. \$79.95 (430 pp.). ISBN 3-540-20846-1

When I was asked to review Boye Ahlborn's *Zoological Physics: Quantitative Models of Body Design, Actions, and Physical Limitations of Animals*, I was tremendously excited. I have taught courses in biomechanics for the past 25 years and have long been captivated by the yin and yang complementarity of biology and physics. Physics has clearly constrained biological evolution, but organisms have also repeatedly come up with bizarre



Alan E. Shapiro is a professor of physics and of history of science and technology at the University of Minnesota, Minneapolis. He is the editor of *The Optical Papers of Isaac Newton* (Cambridge U. Press, 1984) and teaches a course on art and science in early modern Europe.

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.

Michael LaBarbera
University of Chicago
Chicago, Illinois

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-

