

chapter 3. It is a straightforward and successful approach to determining the amplitudes of the inputs to arbitrarily arranged loudspeakers in order to generate the illusion of sound coming from a location between the loudspeakers.

The meatiest material, higher order ambisonics, is covered in chapter 4. Zotter and Frank introduce the reader to the spherical harmonic decomposition of the sound field in order to determine the loudspeaker inputs. They also explore the relationship of VBAP to higher-order ambisonics and describe various refinements that can improve the listener's experience of a sound recording. Subsequent chapters deal with signal flow

effects, ambisonic microphone arrays, and compact loudspeaker arrays.

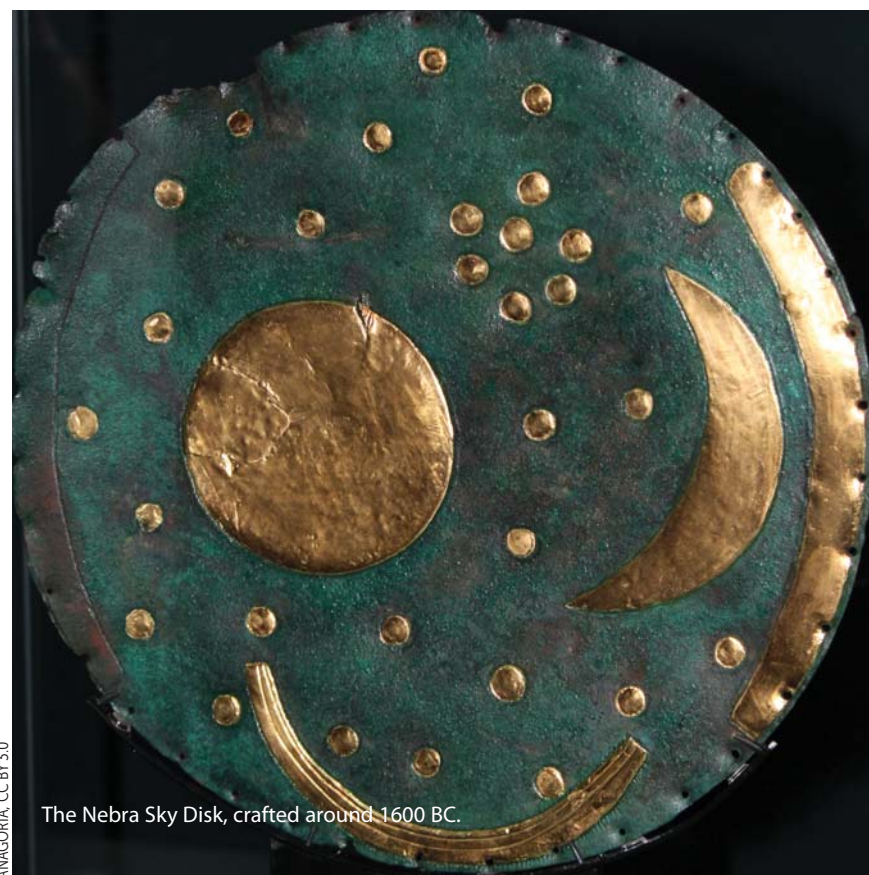
Zotter and Frank include an extremely useful bibliography of research in the field and provide many practical and free software options. The authors also helpfully describe several experiments of what listeners perceive as the source of a sound generated by the various recording techniques and their associated panning functions. However, they barely discuss the extent to which various recording strategies are able to replicate the physical properties of the recorded sound field, particularly in the earlier chapters. Chapter 6, on higher-order ambisonic microphones, comes closest to providing some physical

insight; it presents the classical problem of a rigid sphere scattering sound waves, shows the steps necessary to reproduce a sampled version of the sound field, and offers some helpful simulations of the resulting pressure distributions.

Ambisonics makes some useful contributions, but the picture is far from complete. There is still room to provide an even deeper understanding of those approaches to sound recording and reproduction. The subject will doubtless continue to fascinate scientists and engineers for some years to come.

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The Nebra Sky Disk, crafted around 1600 BC.

From Cave Art to Hubble A History of Astronomical Record Keeping

Jonathan Powell
Springer, 2019.
\$29.99 (paper)



tronomer and author Jonathan Powell daringly navigates those obstacles for us in his *From Cave Art to Hubble: A History of Astronomical Record Keeping*.

Powell opens *From Cave Art to Hubble* with the black hole in the Messier 87 galaxy, a staple of black hole research for more than two decades. The author then turns his attention to archaeology and tells us about a collaboration between historian of religion Alistair Coombs and chemical engineer Martin Sweatman. The two argue that images of animals and a human-bird hybrid at the French Lascaux cave from around 15 000 BC and engravings on T-shaped monoliths at Göbekli Tepe in Turkey from roughly 9000 BC memorialize comets and terrestrial impacts. Although the paintings and monuments contain no obvious images of comets and no evidence exists of terrestrial impacts during the time of the Lascaux cave paintings, new geological evidence supports the idea that a comet impact may have occurred around the time of the Göbekli Tepe site's construction.

The geological evidence is intriguing, but we will never be able to recapture the thoughts of Paleolithic artists to learn if some of their greatest works were inspired by astronomical catastrophes or by

The rich past of astronomical discovery

Exploring the history of astronomy is a more challenging journey than one might expect. To understand how humans have viewed the stars, readers must

be ready to grapple not only with astronomical concepts but with archaeological discoveries, ancient mythology, and the human imagination. South Wales as-

beacons of light in the night sky. Powell might have done well to consult two other resources on the origins of astronomy: *The Roots of Civilization: The Cognitive Beginnings of Man's First Art, Symbol, and Notation* (1971) by the late Peabody Museum scholar Alexander Marshack and the documentary *Lascaux, le ciel des premiers hommes* (*Lascaux, the sky of the first men*; 2007) depicting the work of archaeo-astronomer Chantal Jégues-Wolkiewicz. Marshack meaningfully demonstrated that prehistoric humans etched and painted lunar and seasonal time-factored markings on cave walls and portable objects during the Upper Paleolithic. Jégues-Wolkiewicz's work argues that the cave art at Lascaux depicts details of specific constellations as they were seen in the night sky during that epoch.

Powell regains his footing when he moves from Lascaux and Göbekli Tepe to a host of other astronomical artifacts: the Nebra Sky Disk of the German Bronze Age, the Dendera Zodiac from ancient Egypt, and the Roman Farnese Atlas. Although those artifacts have been thoughtfully analyzed by scholars in a range of disciplines, they are not often discussed

in books about astronomy or the history of science, which makes them a valuable addition to Powell's work. In those passages, *From Cave Art to Hubble* convincingly ties the ancient past to the present by introducing readers to artifacts that have been astronomically dated and that we can relate to our own night sky.

Powell then takes the reader to the area of his core expertise. *From Cave Art to Hubble* covers historical records of supernovae from around the world; observations on the movements of planets from ancient times; astronomical timekeeping among the ancient Chinese, Egyptians, and Persians; the global historical observation of comets; and an overview of the great observatories in the past four centuries. The depth of this material reflects the author's clear knowledge of the subject matter.

Powell finishes the book with a discussion of the Younger Dryas impact hypothesis, which suggests that a comet or disintegrating asteroid struck Earth some 12,800 years ago in the Northern Hemisphere. That terrestrial impact is proposed to have dramatically shifted the climate into a harsh winter period that led to the extinction of Pleistocene megafauna, in-

fluenced the course of civilization, and may be connected to Göbekli Tepe.

The connections between modern discoveries and ancient astronomical observations allow us to ponder all of the intellects that enabled astronomy to be not just science for the sake of science, but a reflection of our inherited interconnectedness to the cosmos. Powell includes a comprehensive glossary that may be of value to both the specialist astronomer and the general audience. However, the book does not include a bibliography, which would have been helpful for further exploration and for ascertaining the strength of the author's sources.

From Cave Art to Hubble is a book to be read and then reread for further reflection as new data and artifacts from our past are uncovered. Powell's work scatters beams of light in the darkness of our astronomical heritage, showing us the rich history of humans exploring the planets, stars, and comets that fill our night sky. The book is a must-read that enables readers to explore both where we have come from and the possibilities that lie ahead.

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NEW BOOKS & MEDIA

Fly, Fly Again

Katie Jaffe and Jennifer Lawson, illustrated by Tammie Lyon

Greenleaf Book Group Press, 2020. \$15.95

Neighbors Jenny and Jude combine their knowledge of lift and steering to build a flying craft in this colorful book aimed at young elementary school students. Like many children's books, *Fly, Fly Again* is written in rhymes, but their meter often feels a beat or two off and can be awkward to read aloud. But the charming illustrations and the encouraging message about learning and trying again make this a good choice for young tinkers. Astronaut Buzz Aldrin contributes a short foreword.



—MB

Thinkrolls

Logic Puzzles for Kids

Avokiddo

iTunes, 2019 (version 1.4.3). \$3.99

Aimed at children ages 3–8, this physics-based tablet and cellphone game challenges players to solve increasingly difficult mazes by avoiding or overcoming obstacles. Players have to climb, bounce, and roll their way through the puzzles and use basic physics concepts like momentum and force to advance. There is an easy mode for kids under six and a hard mode for older children. The game is also available for Android and Kindle devices.

—MB

Ghost Road

Beyond the Driverless Car

Anthony M.

Townsend

W. W. Norton, 2020.
\$27.95

Like the magical flying carpets of Arabian lore, driverless cars could promise a wondrous future of care-free transportation—or they could hasten the decline of civilization as we know it.

That uncertain future is the theme of *Ghost Road*, in which Anthony Townsend, an urbanization and digital technology consultant, discusses how automated vehicles (AVs) could transform not only transportation but also daily life, city planning, commerce, and more. Whether AVs lead to safe, energy-efficient vehicles affordable to all or ever-increasing traffic congestion, carbon emissions, and class inequalities, Townsend argues, is entirely up to us and the corporate and public policies we put in place.

—CC

