BOOK REVIEWS

***Cosmic Discovery: The Search, Scope, and Heritage of Astronomy*, by Martin Harwit. (Cambridge, Cambridge University Press, 2019). Pp. xxvi + 348. ISBN 978-1-108-72204-9 (paperback), 172 x 246 mm, US $45.**

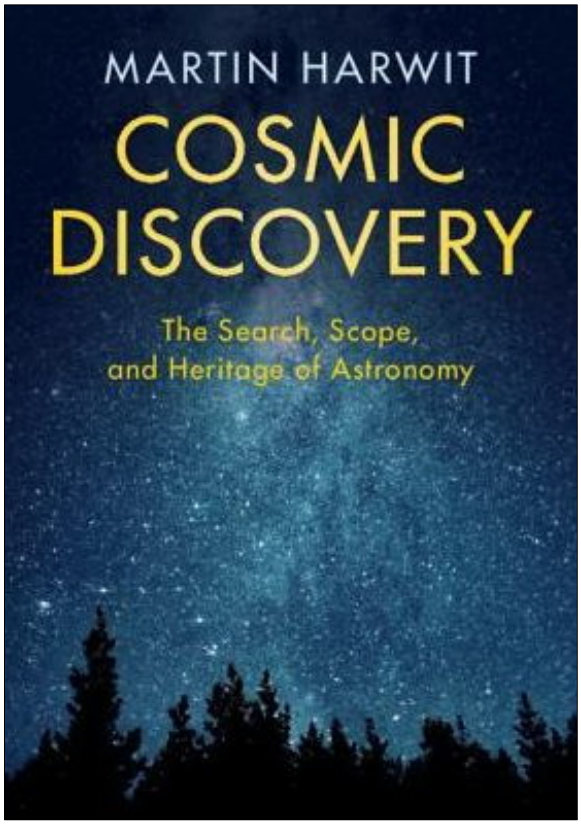
Nearly four decades ago, astronomer Martin Harwit investigated the nature of astronomical and planetary discovery with the goal of answering two questions: first, which subfields hold the most potential for discovery, and second, what can be done to help facilitate new astronomical discoveries. Harwit's grand attempt at answering seemingly unanswerable questions has been rereleased after nearly four decades, with a new preface written by the author.

While the 1981 edition of *Cosmic Discovery* focused on the questions astrophysicists were asking in the late 1970s, the 2019 rerelease does not dwell on what astronomers have learned since the original edition or what new questions have arisen. Many of the questions astronomers were asking in the 1970s remain unanswered, Harwit argues, so he has therefore chosen to rerelease *Cosmic Discovery*, unchanged, to reiterate and emphasize his proposed path forward to assure further progress in astronomy. While this unaltered rerelease does make the text easily available in print to new readers, Harwit missed an opportunity to expand on his earlier work. While our knowledge of the Universe has increased greatly in the decades since its original release, *Cosmic Discovery* can give those in the astronomical community much to consider when deciding on research agendas.

To determine which areas of astronomy hold the greatest potential for discovery, Harwit proposes that one must first determine the number of individual and unique cosmic phenomena that have already been discovered and the number that remain to be discovered. Harwit describes 43 types of astronomical phenomena discovered by the late 1970s, providing a succinct history of each, and speculates, with some mathematical argument, that this number represents roughly one-third of the total number of distinct comic phenomena in the Universe.

Though Harwit's choice of what constitutes a new class of object, and therefore, what constitutes a discovery can be questioned, the establishment of a baseline is useful before asking his reader to consider *how* these distinct cosmic phenomena were discovered. Harwit contends that discoveries are often made by innovators outside the astronomical field (the first radio astronomers typically began as physicists) and using instrumentation developed for the military (rocketry developed for World War Two provided many of the advances needed for the space program). *Cosmic Discovery* is a historical text in that it examines discovery in terms of its social, economic, and political context. These brief summaries will likely work well for astronomers or the general public, but historians will want more context for each brief historical account.

Harwit is particularly focused on the role of technology, predominantly new technologies developed by the military and industry, in astronomnomical progress. The acceleration of astronomical discoveries in the twentieth century was largely spurred on, Harwit argues, by developments in observational instrumentation, both ground- and space-based. Because astronomy



is a primarily observational science (Harwit is skeptical that purely theoretical research can predict new discoveries) and because instrumentation opened up new areas of knowledge in the past, he argues that funding should therefore be directed towards new instrumentation that are sensitive to more wavelengths of light.

With a growing astronomy community, less government funding, more big budget projects and instruments, Harwit asks the reader to reconsider how this community uses its limited resources available, including funding, instruments, and time, to encourage new discoveries and to increase astronomical knowledge. He also asks the reader how a strong education in

physics and engineering could help future astronomers like it helped past astronomers.

Given Harwit's reasoning that new instrumentation can open-up new areas of research, he attempts to predict the most efficient way of allocating time on the largest telescopes and best instruments and methods of funding so that resources are directed towards the most promising research agendas. This information could be most useful for policy makers and government funding agencies who have the ability to direct resources toward the subfields that show the most promise for astronomical discovery. However, though this may hold true for funding agencies, it can be debated the extent to which students are likely to pursue research areas based on the allure of discovery, though funding opportunities will likely help them decide.

Cosmic Discovery is ultimately an examination into astronomical discovery, uncovering the who, where, when, and how. This examination can be superficial in some cases (historians will wish there was more subtlety to the histories presented, and he ignores instrumentation that is either not adopted, quickly replaced, or did not result in the discovery of a new type of cosmic phenomenon), but the focus on the role of the military and government funding, and the political nature of American science in general, help Harwit create a plan for the future. *Cosmic Discovery* is seemingly for policy makers, funding agencies, and new students deciding on which subfield to pursue in order to decide where to invest the astronomy community's limited resources.

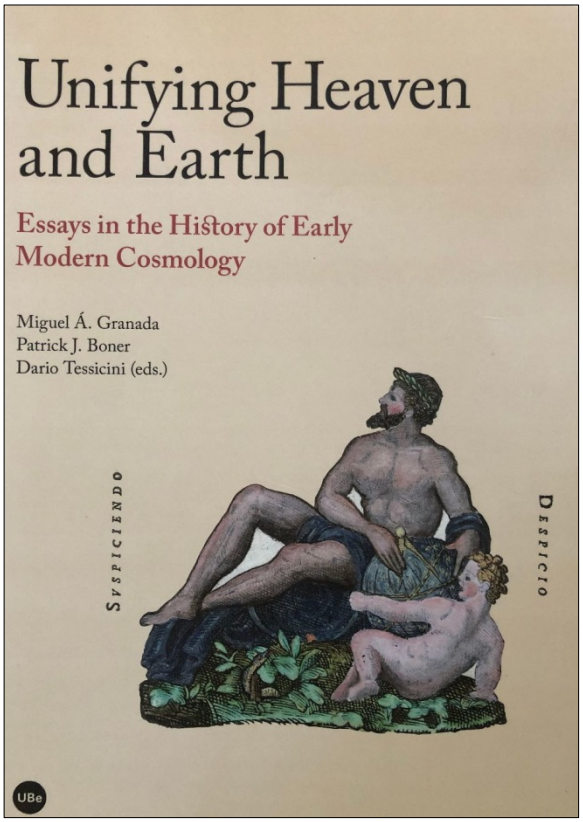
Given advances in instrumentation, changes in government spending, and new cosmic discoveries made during the last few decades, all readers would have benefited from additional sections covering recent astronomical history. The growth of heliophysics as a subfield would have strengthened his argument by showing how the non-astronomers, the military, and industry have come together to push forward a subfield that has led to new discoveries related to the Sun, our atmosphere, and space weather. Providing new examples like heliophysics could have allowed Harwit to reassess his prior recommendations for paths forward and strengthen them for the next forty years.

Dr Samantha Thompson
Smithsonian Institution, Washington DC, USA.
Samantha.m.thompson@gmail.com

***Unifying Heaven and Earth: Essays in the History of Early Modern Cosmology*, edited by Miguel Granada, Patrick Boner and Dario Tessicini. (Barcelona, University of Barcelona, 2016). Pp. 351. ISBN 978-84-475-3960-4 (softcover), 170 x 240 mm, Euro 28.85.**

This collection of 11 essays covering astronomical issues ranging from the fifteenth to seventeenth centuries is one of the most compelling contributions to historical astronomy published so far in this century.

This book may profitably be read in conjunction with the book about Simon Marius, also reviewed in this issue of the *JAHH*. While Marius is only mentioned in a footnote, the topic of the comet of 1618 and the origin of cometary material is covered in both volumes. In a superb 51-page essay on the German astronomer Michael Maestlin and the Comet of 1618, Miguel Granada writes that (like Marius), Maestlin interwove his discussion of cometary origins with speculations on the nature of sunspots. He asserts that "… exhalations or smokes, vapours



or fumes …" are the matter from which comets are born. He likewise believes sunspots "… have an analogy and comparison with clouds …", although he refuses to decide the question as to whether they float around the Sun or adhere to its surface (page 279). While he provided no positive statement on the origin of comets, Maestlin refuted the idea that the exhaleations of which comets are composed arose from Earth.

A lengthy chapter about Paracelsus' ideas also deals in part with comets. Dider Kahn informs us that Paracelsus (a lay theologian) wrote about comets in a series of rare pamphlets from 1531 to 1534, in which

> … his main concern was to undermine the