objectives, because the same database that was applicable to space navigation would provide the internal guidance system of ICBMs—a stark reminder of the Cold War implications that lay behind 'pure' science; creation of the Smithsonian's Prairie Network that photographically aided the recovery of meteorites and offered proofs of their asteroidal origins. We are also reminded of the rise of large computing centers in the physical sciences, the likes of which underwent a kind of competition analogous to that of telescope apertures among leading research institutions.

Chapter 10, "Project Celescope," presents the most in-depth account of the difficult trials attending the design, construction and operation of this component of the Orbiting Astronomical Observatory (OAO-2). On more than one occasion, NASA threatened to pull Celescope away from the SAO and to turn the very much-delayed project over to the Goddard Space Flight Center (GSFC). Production of the UV-vidicons not only proved to be almost impossible for existing manufacturers, but their gradual degradation during the mission required the best minds of the SAO's Research and Analysis Division to salvage the Celescope data that was returned.

Along with the optical initiatives begun on Mount Hopkins, a somewhat parallel development was undertaken (again, in incremental stages) within the domain of radio astronomy. Competing with the proposed Very Large Array (VLA) was the Smithsonian's design of a 440-foot diameter fully steerable radio telescope, housed within a 550-foot diameter radome, which was to be operated by the Northeast Radio Observatory Corporation (NEROC). Here, DeVorkin shows the levels of brinksmanship that Whipple and Smithsonian Secretary S. Dillon Ripley displayed that sought to raise the SAO into a key, if not *the* key, institution that would speak for American astronomy (in the period before the decadal surveys grew to unchallenged status). Ripley himself asserted the "… right to secure direct appropriations for national facilities available to one and all." (Ripley, quoted on p. 235). But in the wake of post-Apollo governmental restructuring and fiscal tightening, especially under scrutiny from the Office of Management and Budget (OMB), Whipple's team was forced to withdraw their proposal in deference to pending allocations (stemming from the NSF) for the VLA.

It was from the OMB's examination of SAO that the first 'seeds' were sown regarding the possible merger of the Smithsonian and Harvard centers into a single, unified institution. These stirrings also came about at the time of increasing tensions between Whipple and HCO Director Leo Goldberg, whose personality and management style contrasted significantly with his predecessor, Donald H. Menzel. Goldberg (and the Harvard Observatory Corporation, HOC) voiced many complaints against Whipple, including their total exclusion from engagement with the MMT, along with the striking imbalance in teaching loads maintained by Harvard faculty but not required of SAO employees. Whipple, DeVorkin argues, fundamentally distrusted, and remained alienated from, Harvard's Astronomy Department. He felt that his autonomy as SAO Director would be threatened by over-site stemming from HOC and as a result, avoided direct involvement as much as possible. Several high-level review panels were convened to study the problem and reached near-unanimous agreement that the two institutions should be merged, with the CfA becoming the final result. Whipple, however, was not to be its leader and was thereby convinced to step down.

These difficult and sensitive issues, involving Whipple's personality and strong ambitions, are handled extremely well by DeVorkin, as are virtually all aspects of the book. They repeatedly showcase the work of a master historian operating at the peak of his craft. One of the foremost achievements of this volume is its construction of a coherent series of sub-narratives, each of which details the large number of individual projects and aspirations pursued during this period, but without losing sight of the overall 'big picture'. Indeed, no better approach seems even remotely possible.

This is an important book: it highlights the emergence of SAO as a major player within postwar U.S. astronomy and space science and its attempts "… to reshape not only patronage patterns for astronomy but also the profile of astronomical institutions …" during the Cold War era (on p. 52). These endeavors achieved tremendous success before the Smithsonian's role within the Federal structure itself was seriously challenged—an action that ultimately reined in the seemingly boundless opportunities sought by its leaders.

Professor Jordan D. Marché II
Department of Astronomy, University of Wisconsin–Madison, Madison, USA.
jdmarcheii@gmail.com

Jupiter, by William Sheehan and Thomas Hockey. (London, Reaktion Books, 2018). Pp. 191. ISBN 978-1-78023-908-8 (hardcover), 175 × 225 mm, US$40.00.

Jupiter is one of a series of books on Solar System objects being published by Reaktion Books. Two other titles in the series were reviewed in the 2018 issue of the *JAHH*. A fifth book, on Saturn, has also been written by William Sheehan and will be published later in 2019.[1] The present volume is co-authored by William Sheehan and Professor Thomas Hockey, whose 1999 book *Galileo's Planet: Observing Jupiter Before Photography* is a highly regarded text on the giant planet.

The Prologue to the book and the first chapter unfortunately promote several discredited narratives. It is attested that the Greeks first learned of sidereal and synodic periods from the Babylonians "... in the fourth century BCE, following the conquest of Babylon by Alexander the Great." (p.10). In reality, the Greeks were aware of such periods from prehistoric times, at least as far back as 2700 BCE (see Tsikritsis et al., 2015). The Prologue ends with a major lacunae: on p. 14, the authors mention conjunctions of Jupiter, Saturn and Mars in certain months BCE, while omitting the years in question! The now-discredited Late Heavy Bombardment hypothesis is promoted on p. 29. The authors then launch a description of planetary migration, based on the idea that Jupiter was deflected from its stable orbit "… by gravitational disturbances produced by the belt of icy material in the outer solar system." (p. 31). The latest research, published by Pirani et al. (2019) after the Sheehan and Hockey book appeared, indicates that it was in fact gravitational forces from surrounding gas in the solar nebula that pushed Jupiter inwards, and that it formed four times further from the Sun than was believed until now.

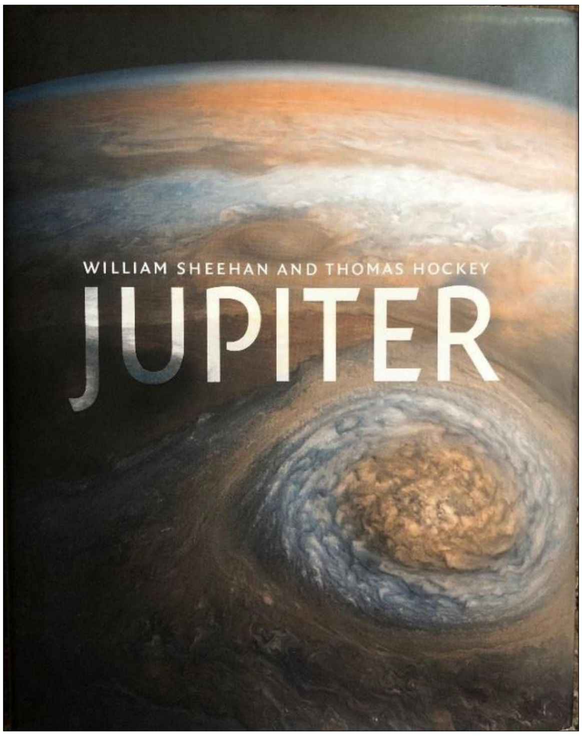
Fortunately the main text of the book is on firm ground. The authors rightly describe Jupiter as "… the undoubted royalty of the solar system …" (p. 34), and as the most visually dynamic planet it is a fan favourite of most amateur astronomers. Even at its smallest apparent size, Jupiter is larger than Mars, and its dance of four satellites is a sight that never gets old (the attribution of the photograph on p. 133 to Europa is incorrect; it is Io).

What constituted the surface of Jupiter remained a mystery for centuries. Giovanni Cassini spoke of having seen the 'snow-covered hills' of Jupiter, then

> A century later, even William Herschel, for a time, and Johann Schroeter made the same mistake in assuming that the white areas were the actual surface and the dark areas clouds. (p. 62).

Sheehan and Hockey detail nineteenth century observations, including what appears to be the first record of the Great Red Spot in 1831. That was due to Heinrich Schwabe, "… today best remembered as the discoverer of the eleven-year sunspot cycle." (p. 64). They give due credit to the amateurs of the nineteenth and twentieth centuries who kept careful records of the planet's cloud features. This "… has proved indispensable to our understanding of its long-term meteorology." (p. 78). Among these were Arthur Stanley Williams who, in 1896, made a map of the wind currents, and Percy Molesworth, who "… made 6,578 timings of features crossing the central meridian." (p. 83). Nonetheless, these amateur efforts were dry as dust to read, and "It is only too tempting to turn away in disgust, as from the lessons of a drab schoolmaster." (p. 79).

On p. 112 the authors state that "… the magnetic poles of Jupiter are 10° askew of the rotational poles; the reason is unknown." The answer likely lies in research published in 2018 but too late for the Sheehan and Hockey to use. Millot et al. report the creation of a new form of



ice known as superionic ice that exists at pressures more than a million times that of the Earth's atmosphere. These conditions exist inside Jupiter, Uranus and Neptune, all of which have off-center magnetic fields. Hydrogen nuclei flow through superionic ice like a liquid while the heavier oxygen atoms remain in a fixed crystal alignment; thus, the ice becomes a conductor of electricity. Sheehan and Hockey do state that hydrogen at a depth of 15,000km in Jupiter is subject to a pressure of 2 million bars and is a conductor of electricity, but the link between that and Jupiter's magnetic pole is not made. Future research will determine if ice is involved in this issue; the atmosphere studied by the Galileo probe indicated "… the extreme dryness of the Jovian atmosphere …" (p. 109), but that was only at 22 bars.

The book includes a chapter on collisions with Jupiter, which are now thought to number on average about 6.5 observable events per year. Among these was a "… faint black spot …" seen by Australian amateur astronomer Anthony Wesley on 19 July 2009. The text states it was an asteroid that caused the impact feature, not an icy object, but the accompanying diagram is unfortunately titled "A comet dies." (p. 150). There is also a chapter on the Juno space probe that is orbiting Jupiter until 2021, but only preliminary science observations were available at the time of writing.

This book is especially strong on a survey of amateur observations of Jupiter, and for that reason alone it is a useful addition to the literature. There is still work to be done for the most dedicated amateurs who use planetary cameras to capture 200 images per second that can then be processed with advanced software, as mentioned in the final chapter, but whatever your motive for observing Jupiter it will always inspire awe, as befitting the "… king of the gods of Mount Olympus." (p. 13).

Notes

1. In the interests of full disclosure, I should mention that I am writing the Asteroids book for the series.

References

Millot, M., and 9 co-authors, 2018. Experimental evidence for superionic water ice using shock compression. *Nature Physics*, 14, 297–302.

Pirani, S., Johansen, A., Bitsch, B., Mustill, A., and Turrini, D., 2019. The consequences of planetary migration on the minor bodies of the early Solar System. *Earth and Planetary Astrophysics*. arXiv: 1902.04591

Tsikritsis, M., Moussas, X., and Tsikritsis, D., 2015. Astronomical and mathematical knowledge and calendars during the Early Helladic era in Aegean "Frying Pan" Vessels. *Mediterranean Archaeology and Archaeometry*, 15, 135–149.

Dr Clifford J. Cunningham
Centre for Astrophysics, University of Southern Queensland, Toowoomba, Queensland, Australia.
cliff.cunnigham@usq.edu.au

American Eclipse: A Nation's Epic Race to Catch the Shadow of the Moon and Win the Glory of the World, by David Baron (New York, Liveright Publishing, 2017). Pp. [xviii] + 331. ISBN 978-1-63149-016-3 (hardcover), 167 × 246 mm, US$27:95.

On 21 August 2017 a total solar eclipse was visible across the USA, and received tremendous attention from the American public. It also inspired an avalanche of new books on total solar eclipses. Some were written by experienced astronomers or astronomy journalists and published by leading astronomy publishing houses (e.g. Bakich, 2016; Littmann and Espenak, 2017) but as an astronomical historian I was particularly interested in any book that focused on the solar eclipse of 29 July 1878—especially if written by a professional astronomer or experienced science journalist. Fortunately there was one such book, written by award-winning science journalist David Baron.

It is clear from the outset that David Baron knows his craft, for he has written a book with 19 chapters and more than 340 pages that includes 44 pages of General Notes and notes specific to each chapter; a 20-page 'Select Bibliography'; and 7 pages of Acknowledgements.

Accordingly, this is a very well-researched book, and this is reflected in the chapters, where Baron succeeds in writing an entertaining narrative that weaves together scientific information, biographical details of the 'key players', and historical, cultural, political and economic factors that led to the success or otherwise of the various eclipse expeditions.

The book begins with a double page map that shows the path of totality, extending from the Rockies in Washington State, across the mid-west, and exiting the USA just west of the Mississippi delta.

In the course of the ensuing chapters we are introduced to a succession of well-known astronomers (Cleveland Abbe, Henry Draper, William Harkness, Samuel Pierpont Langley, Joseph Norman Lockyer, Maria Mitchell, Simon Newcomb, Christian Heinrich Friedrich Peters, Arthur Cowper Ranyard, James Craig Watson, and Charles A. Young), to telescopes, spectroscopes and Edison's revolutionary tasimeter (which was a dismal failure), and even to the 1874 transit of Venus and the postulated intra-Mercurial planet, Vulcan.

Of all those who ventured to the mid-West to view the eclipse, the inventor Thomas Edison was very much the celebrity, and for this reason Baron weaves considerable text around this remarkable character.

> Although Edison possessed neither academic credentials nor experience with eclipses, the young inventor attracted the lion's share of press attention. (p. 101).

The other person to whom Baron devotes considerable attention throughout his book is Maria Mitchell, America's leading female astronomer, who also led an 1878 eclipse expedition to the mid-West.

The destinations of the different eclipse parties stretched like a ribbon across the mid-West, some with familiar names like Denver, Pikes