publishing the photograph and the Keats quote together in 1969, *The Times* "… brings the image into the proximity of fantasy and science fiction." (page 62). Romantic lyric poetry of the nineteenth century, inspired by astronomy, was simply re-stamped as the iconic quote for the twentieth-century space age. Citing post-Apollo era poems by Heaney and Milosz that teem "… with optimistic cosmic images …" (page 136), Greaves comes to the conclusion that "Above all, astronomy becomes a way for them to imagine poetry as a vocation and a means of world-making." (page 138). While Greaves does not draw the parallel, this evoked for me *The Description of a New World, Called the Blazing World*, a 1666 work by Margaret Cavendish that is very in the world-making genre. For a recent treatment of *Blazing World*, see Helfer (2024). Greaves herself waxes poetic in the book's final line:

> Poems in space are meant to outlast the species that made them; they won't save us, but they are poignant self-elegies, cosmic relics of an ancient planet. (page 202).

I did not detect any typos, but there is a problem with the footnotes. At the end of the first paragraph on page 19, a quote is given with a footnote number 6. This should have been numbered 60, but it is missing from the bottom of the page. The following footnote, which is numbered 60, does appear, but of course it should have been 61. So, one missing footnote out of 114 in the Introduction, which is a long 35 pages.

For those who want to explore further the poetic Romantic ideas of both time & space, and subjectivity & aesthetics, I recommend a new book by David Collings (Professor of English at Bowdoin College). It is a most valuable extension of this excellent book by Greaves.

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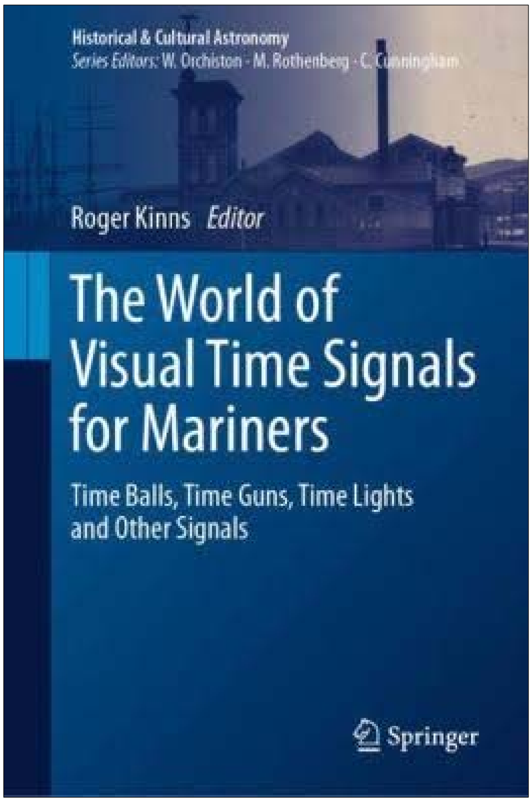
***The World of Visual Time Signals for Mariners: Time Balls Time Guns, Time Lights and Other Signals*, edited by Roger Kinns. (Cham, Springer, 2024). Pp. x + 471, ISBN 978-3031573330 (hardback), 160 × 241 mm, US$199.99.**

Roger Kinns will be well known to readers of this journal, particularly for his many articles on the history of time balls and other early time signals worldwide (e.g. Kinns, 2022). With a background in engineering and a keen insight into history, he is well suited to the task of this volume, which brings together his past work and much new work illuminating a sometimes forgotten but important era of time dissemination and its role in navigation. Although Kinns is listed as the editor of this volume he actually authored 26 of the 28 chapters. The authors of the other two chapters are Douglas Bateman, who writes at length on the evolution of the famous Greenwich time ball, and Paul Fuller, an expert on the early history of British time signals. Altogether, they have provided a wealth of information and insight into this fascinating subject.

The importance of time signals closely parallels the rapid adoption of ship chronometers beginning in the 1830s, the rival to the standard 'lunar distances' method for determining longitude. As accurate as they were, each chronometer had its own error and needed to be 'rated' as to exactly how fast or how slow they were going so this could be taken into account in the longitude calculations. National observatories such as Greenwich and the U.S. Naval Observatory were the keepers of accurate time through standard pendulum clocks such as those of Kessels or Parkinson and Frodsham. Time was determined by astronomers using transit telescopes to observe certain well-known 'clock stars' or the Sun as they crossed the meridian. In other words, the Earth's rotation served as a kind of clock. Transit instruments were standard equipment at most observatories in the nineteenth century, and along with transit circles used for determining declination, were also used for astrometric purposes, as most recently documented in a special issue of the journal *Cahiers François Viète* (Belteki et al., 2023). After transit instrument observations the problem then was how to disseminate this time as accurately as possible to mariners and the general public. Thus the need for visual time signals, in the era before the telegraph and eventually the wireless.

This need for time dissemination led to some ingenious devices, and the evolution of visual time signal technology in the nineteenth and early twentieth centuries is the subject of this book. Although various methods were



proposed and implemented, such as time guns (for which mariners had to take into account distance and the speed of sound), time balls quickly became the preferred signaling method, either at noon in North America or at 1 pm in much of Europe, the latter allowing for the latest observations crossing the meridian at noon.

Kinns recounts just how this happened, especially through the efforts of Captain Robert Wauchope (1788–1862) of the British Royal Navy. In 1818 he first proposed a shutter signal for disseminating time. The British Admiralty took no action, but Wauchope persisted, proposing in 1824 hauling down a flag at mean noon as a visual signal. In 1829 a trial signal was implemented at Portsmouth using a ball instead of a flag, an innovation that Kinns suggests may have been introduced by the Admiralty rather than by Wauchope himself.

Wauchope persisted in his attempts to spread the idea of a time signal for navigation around the world. As part of his efforts to have his time ball signal widely used, he wrote to the American Government in 1830 while the U.S. Navy was establishing the Depot of Charts and Instruments, forerunner of the U.S. Naval Observatory. In 1980, as part of my research on the history of the U.S. Naval Observatory (Dick, 2003) and Ian Bartky's research on the history of timekeeping in America (Bartky, 2000), we discovered Wauchope's correspondence in the U.S. National Archives. Much to our surprise, Wauchope described a Portsmouth time ball erected in 1829, regulated by the transit instrument at Portsmouth Observatory. This was a revelation, since the Greenwich time ball, erected in 1833, had long been considered the first time ball.

In our joint paper (Bartky and Dick, 1981) we documented how the world's first time ball was erected in Portsmouth in 1829. What we did not know, and what Kinns has established with British archives, was that this Portsmouth time ball was only used for trials in 1829, and had an undetermined limited lifetime (Kinns, et al., 2021). As it turned out, no unambiguous operational time-signal device was erected in Portsmouth until 1856 (page 155), and none in the United States until a time ball was installed at the Naval Observatory in 1845 (Bartky and Dick, 1982). As Kinns points out, ironically the Washington time ball was primarily used for time dissemination to the public, Washington not being a major port. But by 1845 the Washington time ball was the world's twelfth, and most of those were used both for navigation and by the general public. In the United States alone there were 9 time balls by 1898, 16 by 1904, and 20 by 1908, 19 of which were dropped using telegraph signals, most often from the Naval Observatory. This is testimony to the usefulness and adaptability of this technology.

Meanwhile the idea of visual signals to rate chronometers and disseminate time to the public had also caught on around the world. In Part II of this volume Kinns meticulously documents the spread of this technology in many forms. 18 of the 21 chapters of

Part II are organized by countries and regions, complete with maps based on British Admiralty lists of time signals and color coding of the types of signals used. Although dominated by time balls, other types of signals included guns, discs, various forms of semaphores, flags, whistles, sirens, and even 'time lights', the latter in its earliest form simply a shutter with an oil lamp, evolving to electric time lights in the twentieth century. Employing his engineering background Kinns describes in detail these often-ingenious devices and their sometimes sophisticated variations, indicating the importance of time dissemination not only for navigation but also for the general public. Accuracy was the watchword for navigation: an error of one second of time was equivalent to almost half a kilometer for a ship at sea at the equator. There are surprises in this history: it turns out the small island of Mauritius in the Indian Ocean scooped Greenwich by a few months in 1833 with its own sophisticated form of time ball (Kinns, 2020: 279–294). Nonetheless, the Greenwich time ball rightfully remains the best-known in the world, and Douglas Bateman's beautifully detailed description of how it has evolved over the last two centuries is a case study in technological innovation.

The era of time balls ended in the early twentieth century. In his revealing Chapter 9 "Worldwide Evolution of Visual Time Signals After 1880", Kinns graphs the number and types of time signals from 1880 to 1947. The graphs clearly show that time balls predominated over this period, followed by time guns, with other types of signals coming in at much lower in frequency—a kind of technological selection in which accuracy was paramount. Time balls peaked in the first two decades of the twentieth century, not surprisingly as wireless radio time signals began to dominate time dissemination, eventually supplemented by satellites. The Washington time ball was moved in 1885 to the Old Executive Office Building next to the White House, and was in operation until 1936 providing time to the public.

Time balls continue to be seen today, used only for historical and ceremonial purposes, the most famous examples being the time ball drop in New York City's Times Square on New Year's Eve, and the Greenwich time ball still dropped at 1 pm every day for the benefit of tourists. The Lyttleton time ball near Christchurch, New Zealand, was rebuilt after being mostly destroyed during the 6.3 earthquake of 2011. It reopened in 2018 to much fanfare, a persistent symbol of a bygone era.

Just how common time balls were in the nineteenth century was brought home by an event organized the U.S. Naval Observatory for New Year's Eve 2000 and 2001, Y2K and the millennium respectively. The U.S. Naval Observatory actually built a new time ball for this occasion at its Massachusetts Avenue site as part of a much larger project spearheaded by the Observatory with the cooperation of Commission 41 (History of Astronomy) of the International Astronomical Union. As the New Year swept around the world from the International Date Line, time balls were dropped at midnight local time beginning in New Zealand, followed by Australia, South Africa, Sweden, the UK, New York City Times Square, the U.S. Naval Observatory in Washington, D.C., and several other sites in the United States. Altogether several dozen sites participated (Dick, 2020). Moreover, most sites synchronized their events via the Global Positioning System satellites, for which the Naval Observatory (keeper of the Master Clock of the United States) synchronizes the time. This juxtaposed the old and the new time dissemination systems, emphasizing how time dissemination accuracy has improved from a few tenths of a second with the time ball to a few billionths of a second with GPS.

In his concluding remarks Kinns, who is generous in his citation of previous work, discusses open questions for further research, including gaps in time signal history, uncertain dates, and key documents yet to be discovered. For example, limitations of time and language precluded a study of in this volume of time signals in China and Japan, which would make an interesting compareson. Kinns modestly describes his book as an "initial framework", but it is much more than that: it is a solid and extensively researched history that fills a huge gap in the literature and is unlikely to be superseded anytime soon. In a broader sense, because time balls and other time signals were synchronized by astronomical observations, they are yet another example of the impact of astronomy on society.

This volume is well produced and beautifully illustrated with numerous color images. Unfortunately, it comes at such a steep price that it will likely be purchased only by libraries. But Kinns has given the results of his considerable labors to the world, and is to be congratulated on a job well done. This is another excellent entry in Springer's Historical and Cultural Astronomy series, which now consists of more than three dozen volumes, including *Essays on Astronomical History and Heritage*, a tribute to Wayne Orchiston on his 80th birthday (Gullberg and Robertson, 2023), which also contains a chapter in which Kinns summarizes his time signals work.

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