So far as I know Bill had no prior experience teaching. I did not regret missing out on taking PH 236 from Thorne, however. Press taught a splendid course, unlike any other I had at university. One aspect stands out in memory. Those of us taking the course were used as beta testers of what ultimately became *Problem Book in Relativity and Gravitation* by Lightman, Press, Price & Teukolsky (Princeton University Press). Each week, we were given fifteen to twenty problems with solutions attached. We were to work through as many as we desired, consulting solutions as needed, and flagging any errors we found, or supplying solutions of our own. (As I recall, none of mine made it into the published version.) We would set aside one problem to work without consulting the solution, and mark it as such for the graders (Saul Teukolsky and Alan Lightman, before his career move to literary fiction). The honour system at Caltech ensured we abided by these conditions. For the final exam, we were supplied with all the (corrected) problems *sans* solutions, and enjoined to work as many as we could in three hours. Naturally, everyone took care to review all the problem sets before the day. I can't say how badly this arrangement traduced the norms of postgraduate final examinations, but as a pedagogical matter, I think it worked brilliantly: we got acres of practice applying what we learned from Press and *MTW*, and the exams were the least stressful of any I had as an undergraduate.

The third quarter of the course was devoted to physical cosmology, mostly taught using Weinberg's *Gravitation and Cosmology*, the account of cosmology in *MTW* being its weakest part.

In the same issue, Helbig also reviewed[2] Carlo Rovelli's *White Holes*. At one point he refers to Dante's *Paradise Lost*. May we look forward to seeing Milton's *Inferno*?

Yours faithfully,
John A. Morgan

5626 Stardust Road
La Canada
CA 91011
USA

2024 June 10

References

(1) P. Helbig, *The Observatory*, **144**, 150, 2024.
(2) P. Helbig, *The Observatory*, **144**, 157, 2024.

REVIEWS

Space: The Human Story, by Tim Peake (Century), 2023. Pp. 328, 23·5 × 15 cm. Price £22 (hardbound; ISBN 978 1 529 91350 7).

More than six decades ago, a 27-year-old lieutenant in the Soviet Air Force, named Yuri Gagarin, made history by becoming the first human to leave our

planet and experience the alien environment of outer space. After completing one orbit around the Earth, the courageous young man with the infectious smile ejected from his spacecraft and parachuted back to the steppes of Kazakhstan, to be greeted by a cow and two bemused peasant farmers. Since Gagarin's pioneering feat, well over 600 people from many nations have risked their lives to venture beyond Earth's atmosphere and explore the 'final frontier'. Their stories are the focus of this historical summary written by UK astronaut Tim Peake, who spent six months on the *International Space Station* in 2016. The book includes many of the most memorable events of the Space Age, covering the exploits of the early pioneers who ventured forth in the Vostok, Mercury, and Gemini missions, the Apollo lunar expeditions, and the orbital workshops that culminated in the giant *International Space Station*.

The account follows a logical format, starting with a chapter about how astronauts are selected, then moving on to preliminary training and assignment to a mission. The remaining chapters are devoted to the launch process, operations in orbit, walking in space, and returning back to Earth. Although Peake does include some anecdotes from his astronaut career, and refers in places to the forthcoming Artemis lunar missions, most of the book is focussed on the historic achievements, problems, and failures of the US and Soviet/Russian space programmes since Gagarin's breakthrough in 1961 April. There is no discussion of the Chinese human space programme or the recent advent of commercial space tourism, and the book's only illustrations are provided by two inserts of colour photos.

Although most of the material has been covered in other volumes, the book is an entertaining read and I would recommend it to anyone not familiar with the exploits of the spacefarers who have volunteered to leave our planet behind in order to explore and exploit the near-vacuum of space. — Peter Bond.

Japan in Space: Past, Present and Future, by Brian Harvey (Springer Praxis), 2023. Pp. 421, 23·5 × 15·5 cm. Price £27·99 (paperback; ISBN 978 3 031 45571 1).

Brian Harvey has been writing about global space activities since the late 1980s, covering the Russian, Chinese, European, Indian, and American space programmes. This volume is a follow-on to two previous books which largely focussed on developments in Japan, bringing the story up to date. This time, the author concentrates solely on the evolution of the Japanese space programme, from its early rocket experiments and the launch of its first satellite in 1970, to the development of sophisticated launch vehicles and spacecraft, and the country's participation in the *International Space Station* (*ISS*) programme.

Today, few outside the scientific community are aware of Japan's significance as a key partner to other leading space powers, most notably the United States and Europe. However, the country has made its mark over the past 50 years by developing its own military surveillance, engineering, and navigation satellites; contributing the *Kibo* science laboratory to the *ISS*; creating a family of indigenous launch vehicles; and making history by returning the first surface samples from two asteroids.

Harvey's thorough, detailed account examines the early history of Japan's space programme, the country's current state of development, and its future plans. He also describes the infrastructure that includes Japan's ocean-side launch sites, training centres, testing facilities, and tracking stations. Another area of focus covers the political and financial difficulties that the country's space industry has faced, not least an ambivalent relationship with the United States.

Once the premier spacefaring nation in Asia, Japan is now left in China's shadow. However, the future still holds much promise, including missions to Mercury and the moons of Mars, and the long-term prospect of Japanese astronauts setting foot on the Moon and driving roving vehicles across its surface. — Peter Bond.

How to Write and Publish a Scientific Paper, 9th Edition, by Barbara Gastel & Robert A. Day (Cambridge University Press), 2024. Pp. 348, 23 × 15 cm. Price £27·99/$34·99 (paperback; ISBN 978 1 009 47753 6).

If you are an established professional scientist, you probably think you already know how to write a scientific paper, and of course that's essentially true. But a quick glance at this book might be enough to tell you that you still have things to learn. For first-time paper writers, it will be very useful indeed. This is the ninth edition, which argues that people do find it helps them.

When I looked at the list of contents, I was not surprised. Every conceivable topic is covered, together with quite a few that I would not have thought of. There are eight main sections: 'Preliminaries' (including such basic topics as What is Scientific Writing? and What is a Scientific Paper?); 'Preparing the Text', with subsections on all the necessary parts from Title to References; 'Preparing the Tables and Figures'; 'Publishing the Paper', starting with an explanation of Copyright; 'Doing Other Writing for Publication'; 'Conference Communications'; 'Scientific Style' (including Use and Misuse of English); and 'Other Topics in Scientific Communication', including How to Write a Thesis and How to Work with the Media. There are four useful Appendices (including Words and Expressions to Avoid, with two columns: Jargon and Preferred Usage; we would all benefit from looking at that one).

The text is clearly and logically written, so the book is a pleasure to read. It is lightened from time to time by relevant cartoons, including two from Peanuts. There is a pertinent quotation at the head of each of the 42 sections (*e.g.*, "Manuscripts containing innumerable references are more likely a sign of insecurity than a mark of scholarship", attributed to William C. Roberts). There is a glossary, a list of References, and an Index. A very useful reference book for all scientists who want to have their work read — and that's all of us, isn't it? — Robert Connon Smith.

Pisgah Astronomical Research Institute: an untold history of spacemen & spies, by Craig Gralley (History Press), 2023. Pp. 158, 22 × 14 cm. Price $23·99 (about £19) (hardbound; ISBN 978 1 4671 5218 1).

PARI, the Pisgah Astronomical Research Institute, was founded in 1998 by Don Cline and his late wife, Jo. It now focusses on both live and remote astronomical education and also houses many collections of astronomical glass plates, deaccessioned by Harvard and many other observatories. But the site started life as a NASA tracking station (1963–1981) and next was owned and operated by the US National Security Agency (1981–1995). The author is a former senior executive of the US Central Intelligence Agency. The above is meant to be an 'other books received' summary.

A review would continue: It isn't often that a book, especially a history book, hits one's mailbox just in time to provide a slice of information needed for the next day's teaching. But this one did. In its tracking-station days, the two 85-foot-diameter radio dishes could pick up the signal from a 5-Watt source on a satellite 200 000 miles away. How much is that in janskys? Well, for some

plausible source of frequency and bandwidth, it's about one. That was indeed the faint end of the radio-source counts in the early days of Big Bang *versus* steady state, Ryle *versus* Hoyle, and so forth, and the very brightest radio sources ranging up to maybe a kilo-Jy. How much is a jansky? It is 10^{-26} watts per square metre per hertz. (Remember that the limiting sensitivity of human hearing is somewhere around 10^{-12} watts per square metre over some frequency range, maybe 300–6000 Hz.)

Why did the book arrive on my desk? It was a present from PARI founder, Don Cline (a friend of long standing) and the author Craig Gralley, each of whom autographed an early page. It has 125 informative footnotes, a short index, some historical black-and-white photos, and some perfectly lovely colour ones, including the PARI campus at night, illustrating how to illuminate grounds and buildings, while sending very little light upward to undarken the dark night skies of rural North Carolina. The *AAATS-3* satellite that took the first colour photograph of the whole earth in 1967 and the first *Earth Resources Technology Satellite* (*ERTS*) were both commanded from the PARI site, when it was called NASA's Rosman Station. The *ERTS* image provided shows New Jersey and was taken on 1972 November 10.

Cline himself is a meteoriticist, and one of the colour photos shows him holding up a piece of chondrite close to three young female students. Two of them look frightened. Perhaps they are remembering the DoD days? Had it ever occurred to you that radomes not only keep the rain off, they keep cameras that pass overhead (on the Other Guy's satellites) from seeing where your spying dishes are pointed. There are lots more photographs and many more unexpected pieces of information. Many thanks Don and Craig! — Virginia Trimble.

General Relativity: The Theoretical Minimum, by Leonard Susskind & André Cabannes (Penguin), 2023. Pp. 387, 20 × 13 cm. Price £10·99 (paperback; ISBN 978 0 141 99986 9).

Leonard Susskind has been a professor of theoretical physics at Stanford for almost five decades. He is best known for his technical work on string theory and various applications of quantum theory. This book is one of many*, with various co-authors, based on his lecture series *The Theoretical Minimum*; the lectures themselves are available as videos on the internet. This is the first book in the series which I have read. Books on General Relativity can be divided into physics-first or maths-first and of course also differ with regard to breadth, depth, and level of (mathematical) detail. This book is rather different in that it is neither strictly maths-first nor physics-first, although it does follow the common pattern of an introductory physics chapter, then a few chapters on maths, before moving on to discuss applications. However, rather than deliver essentially all of the maths first, Susskind presents the basics of tensors, curvature, geodesics, and metrics before three chapters on black holes, but in those chapters brings in more maths (*e.g.*, various types of coordinates) as needed. The Einstein field equations don't appear until the ninth chapter, before the final one on gravitational waves.

It also differs from most other books in that the basic concepts are presented in enough detail actually to learn them relatively easily. However, the details are conceptual, not necessarily mathematical. The emphasis is on understanding,

*So far, there are also books on classical mechanics, quantum mechanics, and classical field theory and Special Relativity. The next volume will be on cosmology, followed by one on statistical mechanics.

not on mechanical calculation. Common topics such as the difference between contravariant and covariant tensors and Christoffel symbols are *explained* rather than just presented. Although one learns only 'the theoretical minimum', this book is probably the best I have read so far for those who actually want to learn General Relativity. The book reads like a series of good lectures, on which of course it is based. (It "is adapted from a course...at Stanford in the Continuing Studies program to an audience of adults"; I'm not sure what Susskind wants to imply about normal students at Stanford.)

By now even Susskind should know that Wheeler didn't coin the term 'black hole', though he did popularize it. Other than that, I noticed no mistakes in the book. Somewhat unorthodox is the fact that equations are not punctuated, and equations, theorems, *etc.*, named after people are usually with neither the definite article nor the possessive form (*e.g.*, "given by Pythagoras theorem", "solving Einstein field equations"). I found it somewhat strange to discuss comparing the observations of someone falling into a black hole with those of someone watching that from afar without mentioning redshift, though the description is, of course, correct. Susskind is also somewhat dismissive of videos (by professional relativists) which purport to show what one would actually see if falling into a black hole and so on, though he doesn't say why. Those minor points don't distract from the main narrative, but might be interesting to follow up for those interested in Susskind's perspective.

There are several black-and-white diagrams scattered throughout the book, and of course, equations, though not a huge number of the latter. There are a few footnotes but neither endnotes nor references; apart from the chapters ('lectures') there is only a short preface by both authors and a six-page small-print index. The book is well written and I will probably read the others in the series, and hopefully review the upcoming one on cosmology in these pages. — Phillip Helbig.

Cultural Astronomy in Latin America, edited by Steven R. Gullberg & César Augusto zen Vasconcellos (World Scientific), 2024. Pp. 398, 23·5 × 16 cm. Price £135 (hardbound; ISBN 978 981 12 8192 1).

Cultural Astronomy in Latin America is a book by and for experts. Its 14 chapters address (mostly) archaeological sites and artifacts associated with the Inca culture and Mayan written records. At the edges, as it were, are (*i*) Mark Raney looking at the star lore of the Hopi and Zuni Indians of the American Southwest and comparing it with the views of the Aztecs of what is now Mexico; (*ii*) Armando Madrid on how astronomy brought by European immigrants to southern Argentina has blended with and survived alongside the myths of the local indigenes, and (*iii*) Walmir Thomazi Cardosa with a "long 20th century" look at a grab-bag of entities from the Brazilian northwest Amazon, including light beams, asterisms, and snake myths. The chapters are not ordered North to South (or South to North) nor early to late, nor even alphabetically by author. Perhaps the chapters are in the order the texts reached the editors. Many of the authors have affiliations in the countries that host(ed) the cultures they have written about. You won't be surprised to hear that these (mostly) pre-Columbian groups of people were interested strongly in what the Sun does (rising, setting, and in between), a bit less strongly in what the Moon does (and trying to fit the two sorts of cycles together), and often also in patterns of stars in the sky and perhaps the motions of Venus among them. These were also the interest of early (and contemporary!) peoples of the Old World. The specific myths are different, though water makes a frequent appearance, as from time to time do pyramids and various circles. And the hope of forecasting rain from the phases of the

Moon (Kepler had similar hopes for his astrology). More realistic were uses of solar phenomena to keep track of times for planting and harvesting crops and thanking the Gods in festivals for successful agricultural years,

How do I know the book was meant for experts? Nearly every chapter uses indigenous words for concepts or phenomena without translation in a glossary. Only rarely does a map locate the site. And the asterisms (that is patterns of stars assigned names and significance different from those of our own Babylonian-to-Greek-to-Lacaille-to-IAU constellations) are mostly described rather than shown as dots on a skymap with coordinates, although the Pleiades are mentioned in several chapters.

Unquestionably there is something to be learned from every chapter, but I was particularly glad to encounter the one by editor Steven R. Gullberg on the Chankillo astronomical complex in north-central Peru. A watercolour of the site, by the editor's wife Jessica Gullberg, graces the cover of the volume. There are 13 towers (about as high as an Editor) along the crest of a ridge, separated by home-pool lengths. An observer situated at either an east or a west observation point will see the Sun rise or set in the gaps between the towers on days like the solstices and equinoxes. The Moon on this somewhat elevated horizon also peeks through from time to time. Dendrochronology and C-14 dating place use of the site around 250–200 BCE, and it is therefore clearly pre-Incan. The same site is identified as one of the most persuasive preliterate astronomical locations in a forthcoming book with very different origins*. — Virginia Trimble.

Einstein in Time and Space: A Life in 99 Particles, by Samuel Graydon (John Murray), 2023. Pp. 317, 20 × 13 cm. Price €14 (about £12) (paperback; ISBN 978 1 529 37250 2).

The 'Particles' in the title are anecdotes. (They are preceded by a nine-page introduction which gives a more conventional but very good overview of Einstein's work, life, and times.) We've all heard anecdotes about Einstein: why he dropped out of high school, his childhood fascination with a compass, the fate of his daughter, his stolen brain, his time at the patent office, and so on. A few of those presented here were new to me: I knew about his newspaper advert offering tutoring, and his friendship with Maurice Solovine, but didn't know (or had forgotten) that they met through his ad. There is also some interesting background information: Einstein famously explained Brownian motion, Brown having found that it applied to all small particles, whether of biological origin or not (initially having observed pollen grains, Brown had at first thought that it was some sort of vital sign), by testing all sorts of materials, including, for some reason, filings from the Great Sphinx of Giza! (Perrin was awarded a Nobel Prize for confirming Einstein's predictions involving Brownian motion.) Also new to me were details of his romance with Marie Winteler, mostly unknown to the world until the corresponding letters were published in the fifteenth volume of Einstein's *Collected Papers* in 2018. (Einstein had boarded with the family of her parents, Jost and Rosa. Einstein's sister Maja married Marie's brother Paul, and Einstein's friend Michele Besso married Marie's sister Anna.)

Similarly to the autobiographical stories of Richard Feynman written up by his friend Ralph Leighton[1,2†], this book consists essentially of only such anecdotes, just briefly discussing Einstein's work or more banal details of his life. However,

*Noah Brosch, *Of Stars and Stones: Diffusion versus Convergence in Archaeoastronomy*, to be submitted shortly for publication, 2024.

†Depending on the edition, for both books Leighton is sometimes referred to as co-author or editor, and for the former Edward Hutchings is sometimes referred to as editor.

twenty-six pages of references to the sources of quotations point the reader to the origin of such anecdotes. The five-page 'Sources and Acknowledgements' section not only lists but also gives information about several biographies of Einstein and other works, by Einstein and others, used in researching the book. The author is the science editor of the *Times Literary Supplement* and the book is very well written, both in terms of content and in terms of style. Those wanting a breezy introduction to Einstein's life as well as those wanting to track down details of one of the many famous anecdotes will find this book very useful. And what a life it was: in 1905, Einstein "was still working six days a week at the Patent Office, he had a one-year-old son to help look after, and that year he wrote twenty-one reviews* for an academic journal. He also moved house in May. And yet he managed to produce five scientific papers in six months, three of which would eventually transform physics." Even that is an understatement: apart from those three, the two papers on Special Relativity and the one on the photoelectric effect, there was the paper on Brownian motion mentioned above and his doctoral thesis on the determination of the Avogadro constant, two of the main papers which made it clear that atoms are real. As Pais[4] points out, his thesis was extremely important at the time and is one of his most highly cited works. Such an output would be impressive even today, but is even more so after having visited the flat he lived in at the time, as I did in 2015. And that was all before he got his first academic job.

I noticed only one mistake: it was not "much later" after the definitive discovery of the acceleration of the Universe about a quarter of a century ago that it was realized that the cosmological constant, which Einstein had introduced for another reason in the first paper on relativistic cosmology[5], could provide the reason for such acceleration. On the contrary, that was clear long before the acceleration had been discovered, at least as far back as the 1920s. Interestingly, the only acknowledgement regarding the scientific content of the book, rather than matters of production and so on, is for someone who checked the physics content and "explained some of the more technical issues of cosmology". Some of the chapters start with a black-and-white photo, most of which are of people. I've already mentioned the 'Sources and Acknowledgements' and the references to quotations. In addition, 'Credits' gives details on both 'Text' and 'Pictures'. As such, this book might be the quickest way to track down the original sources for the topics covered in the book. An eight-page index in somewhat smaller print ends the book.

All in all, a very enjoyable read, even for those who have heard most of the stories before, and a useful jumping-off point for those wanting more details. — Phillip Helbig.

References

(1) R. P. Feynman, "*Surely You're Joking, Mr. Feynman!": Adventures of a Curious Character* (W. W. Norton), 1985.
(2) R. P. Feynman, "*What Do You Care What Other People Think?": Further Adventures of a Curious Character* (W. W. Norton), 1988.
(3) J. Renn, *Einstein's Annalen Papers* (Wiley), 2005.
(4) A. Pais, '*Subtle is the Lord...': The Science and the Life of Albert Einstein* (Oxford University Press), 1982.
(5) A. Einstein, *Sitzungsb. Kön. Pr. Akad. Wiss.*, **VI**, 142–152, 1917.

*Those reviews are neither book reviews nor referee reports, but rather summaries of papers published elsewhere, mostly about thermodynamics, sometimes in languages other than German such as English, Italian, and French. They also provided additional income[3]. See https://einstein-annalen.mpiwg-berlin.mpg.de/home for a summary of Einstein's relationship with *Annalen der Physik*.

From The Library

The Cause of an Ice Age, by Sir Robert Ball (Kegan Paul, Trench, Trübner, & Co.), 1891. Pp. 180, 20 × 13 cm. Price about £9 for a used copy from an on-line bookseller (hardbound; no ISBN).

A popular theory for explaining the ice ages involves the periodic changes in the Earth's orbit and the precession of the equinoxes. This theory is known as 'Milanković cycles' after the Serbian scientist Milutin Milanković (1879–1958), who wrote about this in the 1920s. However, similar theories had been around for some decades before the 1920s.

An earlier version of this theory was proposed by the Irish astronomer Sir Robert Ball (1840–1913), a prolific author of popular books and Royal Astronomer of Ireland (1874–1892), in this book. It was the first volume in a series, *Popular Science*, edited by Sir John Lubbock (1834–1913, later the first Lord Avebury). Ball's writing skill is evident in this highly readable and easy-to-follow little book. He makes a very strong case for the validity of this theory. He demonstrates that if the year is divided into two seasons, summer from vernal to autumnal equinox, then winter from autumnal to vernal equinox in the northern hemisphere, 63% of the Sun's annual supply of heat to that hemisphere is received in summer and only 37% in winter, whatever the condition of the Earth's orbit and axis. (He points out that Sir John Herschel wrongly states that the share is 50% in each season.)

The maximum possible difference between the length of summer and winter is 33 days, so one season is 199 days and the other is 166 days (page 97). When summer is much longer than winter, the 63% is stretched out and the 37% is compressed into a shorter period. He argues that the resultant warm but not hot summers and mild winters must lead to a "beneficent climate" (page 99). Conversely, when winter is much longer than summer, the 37% is stretched out and the 63% is compressed into a shorter period. This means that there are short, hot summers and long, cold winters. "This is the condition required for the development of glaciation. During the rigours of the winter the ice and snow accumulate, while the succeeding brief summer is not able to thaw as much water as has been solidified during the winter" (pages 106–107).

Whatever the merits or demerits of the theory that this book presents, it is an excellent model of how to present a scientific theory to the general public. — Lisa Budd.

ASTRONOMICAL CENTENARIES FOR 2025

Compiled by Kenelm England

The following is a list of astronomical events, whose centenaries fall in 2025. Births and deaths of individual astronomers are taken from *Biographical Encyclopedia of Astronomers* (Springer, 2007) and the on-line Obituary Notes of Astronomers and Obituary List of RAS Fellows. For events before 1600 the main source has been Barry Hetherington's *A Chronicle of Pre-Telescopic Astronomy* (Wiley, 1996). For the 17th to 20th Centuries lists of astronomical events came from Wikipedia and other on-line sources, supplemented by