scientific point of view, leading as it did to the discovery of the coronal green line.

The pioneering spirit pervades this enjoyable romp through the American mid-west. I highly recommend it. It is richly illustrated, and I have honestly only ever seen one or two of the illustrations previously. (Figure 5.1, by the way, is printed upside down. There are few obvious typographical errors.) There is a very good collection of portraits of individuals, observing locations, charts, and drawings and photos of the eclipse. Hockey's book offers sound background details, and nicely sets the 1869 events and discoveries in context. It can either be read from cover to cover or just dipped into at random, as the chapters are self-contained. It is an engaging work, always informative and comprehensive, and — in quite a few places — highly amusing. And what about that quicksand mentioned in the title? Well, I leave that to Hockey's readers to discover, but I might just add that the unfortunate Naval Commander was involved. — Richard McKim.

Nobel Prizes in Astronomy, by Pushpa Khare (Springer), 2023. Pp. 173, 23·5 × 15·5 cm. Price £22·99 (paperback; ISBN 978 3 031 29638 3).

Strictly speaking, there are no Nobel Prizes in Astronomy, but we all know of cases where a Nobel Prize in Physics has been awarded for work very strongly related to astronomy. Research significant enough to merit a Nobel Prize is often not easily explicable to high-school students and we owe this book to Dr. Khare's daughter, who suggested that she wrote an account suitable for students. Recently retired from Utkal University, near Pune, and with plenty of experience in giving popular talks and writing for science magazines, she took up the challenge.

She covers 13 Prizes, starting in 1967 with the award to Hans Bethe for his work on what we now call nuclear astrophysics: the nuclear reactions that happen inside stars and provide the energy source for stars. She recognizes seven categories: 'Stellar Structure', 'Stellar Evolution', 'Radio and X-ray Astronomy', 'Extra-solar Planets', 'Black Holes', 'Gravitational Waves', and 'Cosmology', and devotes one chapter to each category. For each Prize (sometimes several in each chapter) she starts with the citation, followed by some biographical information about the recipient (complete with a photograph in most cases; she did not in time receive permissions for two). She then gives appropriate background information, which for Bethe runs to 12 pages (an overview of the whole of stellar structure), followed by an account of the specific work for which the Prize was awarded.

As well as Bethe, the first chapter includes the 2002 award jointly to Ray Davis Jr. and Masatoshi Koshiba, mainly for their independent 'detection of cosmic neutrinos', using, respectively, the Homestake mine and *Kamiokande* (originally set up to look for proton decay; the full name is *Kamioka nuclear decay experiment*). Davis recorded solar neutrinos, but for a long time there was a puzzle: he detected only about a third of the expected number. It wasn't until the much later *SNO* experiment that it was realized that neutrino oscillations had reduced the number of electron neutrinos during the journey from the Sun to the detector. Koshiba's first detection was of neutrinos from SN 1987A, but later his group confirmed Davis's results for the solar neutrinos. *Super-Kamiokande* was able to detect muon neutrinos and confirmed the *SNO* result.

The 'Stellar Evolution' chapter records the 1983 Prize, shared between Chandrasekhar (essentially for the 'Chandrasekhar limiting mass' of a white dwarf, although the citation is much wider) and Fowler for his seminal work on nucleosynthesis in stars (the famous B^2FH paper is duly mentioned). The next chapter covers two separate Prizes, the 1974 Prize to Ryle and Hewish for radio astronomy and the 2002 Prize to Giacconi for X-ray astronomy. The 1974 citations pick out the invention of aperture synthesis for Ryle*, and "his decisive role in the discovery of pulsars" for Hewish. Jocelyn Bell is of course mentioned, but with no comment on the subsequent controversy. The 2002 citation for Giacconi mentions particularly "the discovery of cosmic X-ray sources", the first of these being Scorpius X-1. He shared the Prize with Davis and Koshiba (see previous paragraph). The differences between optical, radio, and X-ray telescopes are carefully explained.

The idea that there might be planets around other stars has existed for many years, probably for millennia in the more general sense of whether there might be life elsewhere in the Universe, but it was only in 1995 that the first discovery was announced by Michel Mayor and Didier Queloz. They received the 2019 Prize "for discovery of an exoplanet orbiting a solar-type star." Together they had developed a technique that enabled them to measure radial velocities to an accuracy of 10 to 15 m s^{-1}, sufficient to detect very small variations in a star's velocity caused by the orbital motion of a planet around the star, and in 1994 they detected a periodic variation in the motion of the star 51 Pegasi.

The 2020 Prize was awarded to three people: the mathematician Roger Penrose and two observers, Reinhard Genzel and Andrea Mia Ghez, for work on black holes. In 1965, Penrose had shown rigorously that Einstein's general theory predicted the formation of black holes, while Genzel and Ghez in the late 1990s discovered that our Galaxy has a massive black hole at its centre, as had been speculated nearly 30 years earlier.

General Relativity (GR), of course, also features in gravitational waves. Russell Hulse and Joseph Taylor received the 1993 Prize for their work in the 1970s on the binary pulsar, which they observed initially to find the mass of the pulsar. However, they also observed a slow decrease in the orbital period, which they attributed to the emission of gravitational waves. Careful measurements showed a very close agreement between the observed decrease and that predicted by GR, providing indirect evidence for the existence of gravitational waves. Much later, after many attempts to detect gravitational waves directly, starting with Weber's seminal experiments in the early 1960s, three other physicists, Rainer Weiss, Barry Barish, and Kip Thorne developed the idea of laser interferometry (first suggested by two Russian physicists, Gertsenshtein and Pustovoit in 1962) into the *Laser Interferometric Gravitational wave Observatory* (*LIGO*). *LIGO* successfully detected a signal on 2015 September 15 and the award of a Nobel Prize for this work came remarkably quickly, in 2017.

Cosmology has received no fewer than four Nobel Prizes, from the 1978 Prize to Arno Penzias and Robert Wilson for their accidental detection of the cosmic microwave background radiation (CMBR) in 1965 to three this century. The related work by George Smoot and John Mather showing that the CMBR has a pure black-body spectrum and that it has anisotropies at the 10^{-5} level received a Prize in 2006. The discovery by Saul Perlmutter and separately by Brian Schmidt and Adam Riess of the acceleration of the expansion of the Universe was published in 1997 and they received the Prize jointly in 2011. Finally, Jim Peebles was rewarded for a lifetime's theoretical work in physical cosmology by a share in the 2019 Prize (shared with Mayor and Queloz — see above).

*The author gives a percipient quotation from a letter, published posthumously, where Ryle says, "Our cleverness has grown prodigiously — but not our wisdom."

This is an interesting and informative book, written for high-school students but with plenty of stories of interest to other general readers and to professional astronomers. There are a few infelicities in the (American) English, but I only found three typos: on p. 52, four lines from the foot, Royal Society should be Royal Astronomical Society (the famous Chandrasekhar–Eddington disagreement occurred at a meeting of the RAS), on p. 101, line 2, 'Causal' should be 'Casual', and on p. 103, section 6.31 line 1, Martin should be Maarten. A Glossary will help the general reader and there is a useful index (although it doesn't include people's names). There are no references to any of the original work. — Robert Connon Smith.

Introduction to General Relativity and Cosmology, by Ian R. Kenyon (IoP Publishing), 2023. Pp. 307, 26 × 18·5 cm. Price £75/$120 (hardbound; ISBN 978 0 7503 3761 8).

General Relativity is more than 100 years old, and the number of GR textbooks about it probably exceeds 100, beginning with Einstein himself (1920, *Relativity, the Special and General Theory*, translated by Robert W. Lawson from *Uber die spezielle und die allgemeine Relativitätstheorie*) and Arthur S. Eddington (1920, *Space, Time, Gravitation*). The midpoint from then to now is marked by the massive *Gravitation* by Charles W. Misner, Kip S. Thorne, and John Archibald Wheeler (otherwise known as *MTW*). Steven Weinberg entered the fray in 1972 with *Gravitation and Cosmology*, a portent of things to come.

The present volume is a second edition of a 1990 (Oxford University Press) original, very much updated to include gravitational waves, the *Event Horizon Telescope*, and especially cosmology, including the use of Type Ia supernovae to demonstrate the acceleration of cosmic expansion. It is one of five recent texts increasingly weighing down my desk, as part of a quest for a text for an undergraduate major course on General Relativity and black holes for winter quarter 2024. All share a much larger fraction of pages devoted to cosmology, including inflation, details of the CMB, Big Bang nucleosynthesis, and structure formation than is present in the earlier volumes.

Kenyon devoted eight of his 17 chapters to these issues, *versus* four of 44 in *MTW*, one-seventh of one chapter out of nine in Joseph Weber's 1961 *General Relativity and Gravitational Waves*, three of 24 chapters in James B. Hartle's 2003 *Gravity: An Introduction to Einstein's General Relativity*, and, for that matter, three brief sections out of 32 (called 'Considerations on the Universe as a Whole') in Einstein's 1920 monograph. The explosion of cosmology has made most of these volumes too long for a 10-week quarter, or even a 15-week semester, despite sometimes leaving out the classic tests of gravitational redshift, light bending by the Sun, and advance of the perihelion of Mercury (all considered by Einstein). These have the advantage of being reasonably easy to understand. Kenyon includes Mercury and light bending in a chapter with the Shapiro time delay, geodetic precession and frame dragging, and gravitational lensing.

He attempts some history, crediting John Michell in 1787 with the first suggestion that large GM/R can mean an escape speed larger than the speed of light. A similar conclusion by Pierre-Simon de Laplace in 1795 does not appear. The binary pulsar 1913+16 appears as a graph of period change from the time of its discovery up to approximately 2013. The data are perfectly fit by a general-relativistic prediction of energy lost in gravitational radiation. Each chapter has half a dozen or so exercises, including distortion of a human too close to a black hole and calculation of the flux of gravitational-wave energy from the binary pulsar to be expected here in Irvine