REVIEWS

The Universe in a Box: A New Cosmic History, by Andrew Pontzen (Vintage), 2024 (first published 2023). Pp. 251, 19·8 × 13·8 cm. Price £12·99 (paperback; ISBN 978 1 529 92200 4).

Andrew Pontzen, until recently a professor of cosmology at University College London, is now a professor at the University of Durham. While this is his first book, he has popularized science in magazines, on radio, and on television, and is well known in the field of cosmological simulations, the topic of this book. A good move is to start with discussing weather and climate, something people are familiar with; the distinction between the two (details at a particular place and time as opposed to long-term large-scale trends) carries over into cosmological simulations, where the goal is to understand the general behaviour, not to mimic a specific scenario in detail. There are many interesting historical details on weather forecasting, climate simulations, chaos, and so on. The second chapter has a similar discussion with respect to simulations of the large-scale structure of the Universe and the roles of dark matter and dark energy in producing structures such as the cosmic web. History is important here as well and I was happy to meet Erik Holmberg's fascinating optical analogue computer for galaxy simulations for the second time in a popular-science book (for the first, see refs. 1 & 2). Like the details of raindrops or even clouds in weather simulations, individual stars are much too small to be resolved in a cosmological simulation, leading to a discussion of sub-grid approximations, heuristic parameterizations designed to accommodate such small-scale phenomena into the simulation. An important application is the introduction of baryonic physics to refine more straightforward simulations containing only dark matter and dark energy. There is a balanced discussion between the critical claim that one gets out only what one puts in and the increased faith in such schemes when they successfully predict behaviour for which they were not designed. In that respect and others there is good discussion of how one uses simulations as a tool for understanding rather than to mimic reality. An important sub-grid phenomenon in galaxy simulations are black holes and their effects on star formation, worth an entire chapter.

Chapter 5 shifts gears somewhat by moving to quantum theory, but that is relevant due to the role played by quantum mechanics in the early Universe and its potential role in quantum computation. Computation is the subject of the sixth chapter on machine learning in general and its uses in astronomy. While rightly criticizing current exaggerated hype ("ChatGPT … comes across as a bland know-it-all" with its output being "like a mediocre TV script: believable on the surface but with little substance" with aimlessly drifting conversations lacking any large-scale coherence and limited to "the restatement of existing ideas that it found who-knows-where on the Internet")*, Pontzen also considers it a realistic possibility that artificial intelligence could improve enormously and emulate or exceed human thinking in many respects. That leads to a discussion of the simulation hypothesis, the idea that if consciousness is easy enough to simulate, then a typical conscious being is more likely to be simulated than real[3]. The idea has prominent supporters — or at least some who don't think that it is patently absurd and not worth considering — (including the Astronomer Royal[4]), but also prominent detractors (such as George Ellis, who reminded

*On the other hand, a good friend of mine once described conversations between his fellow pupils at school as the mutual exchange of standard statements they had learned by heart; he is now a teacher.

the audience of his view on that topic at a recent philosophy-of-cosmology conference I attended in Milan). Pontzen speculates that such a simulation might employ sub-grid methods, as one would need the entire Universe to simulate the Universe in detail (though if our Universe is simulated, we don't know anything about the universe in which that simulation is running). (However, if simulating consciousness is a goal (and one could argue that simulated consciousness is also consciousness), I wonder why the much easier task of simulating a brain and its sensory inputs is not a more popular topic.) In the same, final, chapter is an over-arching discussion of 'Simulations, science and reality' which also serves as a summary of the book.

This is not a book about the details of simulations[†] but about their purpose, their role within science, even the human side of them, presenting a balanced view by an expert on the subject. Thirteen pages of small-print endnotes sometimes play the role of footnotes but are mostly references, usually to the scientific literature but also to various internet resources. An eleven-page small-print index ends the book. There are no figures. It is well written with a lower than average number of typos and so on. My only real complaint is a paragraph which, while also recognizing his contributions, is strongly critical of Feynman as a person; even if true, I don't see the relevance to the rest of the book nor any reason why Feynman is singled out for such criticism. Apart from that, I can warmly recommend the book. — Phillip Helbig.

References

(1) J. D. Barrow, *The Book of Universes* (Vintage), 2012.
(2) P. Helbig, *The Observatory*, **133**, 232, 2013.
(3) N. Bostrom, *Philosophical Quarterly*, **53**, 243, 2003.
(4) M. J. Rees, https://www.edge.org/documents/archive/edge116.html
(5) R. Davé, *Simulating the Cosmos: Why the Universe Looks the Way it Does* (Reaktion), 2023.
(6) S. Phillipps, *The Observatory*, **144**, 37, 2024.

Steven Weinberg: A Life in Physics, by Steven Weinberg (Cambridge University Press), 2025. Pp. 253, 23·5 × 16 cm. Price £25/$29·95 (hardbound; ISBN 978 1 009 51347 0).

Steven Weinberg's (1933–2021) autobiography will become an invaluable source for future historians of physics and astronomy. His candid memoir of a scintillating life in physics opens with a child's memory of the key books that sparked his innate curiosity about the physical world. George Gamow's creation, Mr. Tompkins, introduced young Steven to the weird world of Special Relativity and quantum mechanics; science-fiction classics likewise stirred his imagination; and from Jeans' *The Mysterious Universe* he gleaned that he "would need special mathematics" to make sense of the universe. 'Making sense' became Weinberg's lifetime goal.

Weinberg was polishing his memoirs at the time of his death. Steven's wife, Louise, has organized and edited them to produce this engaging account of his life as a scientist and public intellectual. Many vignettes of his formative encounters with dozens of leading physicists in the mid-20th Century enrich the narrative. Weinberg's talent as a writer of popular science shines through brightly. He offers many good stories: on working styles, he liked to work on fundamental physics with the TV tuned to the History Channel, a trick that doubled his productivity — absorbing some old knowledge while striving to

[†]Those interested in that aspect might want to consult a book[5] reviewed last year in these pages[6].